MECHANICAL ENGINEERING

November, 1958

POWER ENGINEERING ISSUE

EXPOSITION OF POWER AND MECHANICAL ENGINEERING
New York Coliseum Dec 1-5

ASME ANNUAL MEETING
New York, N. Y., Nov 30-Dec 5

Shell for Power Reactor

CASE HISTORIES

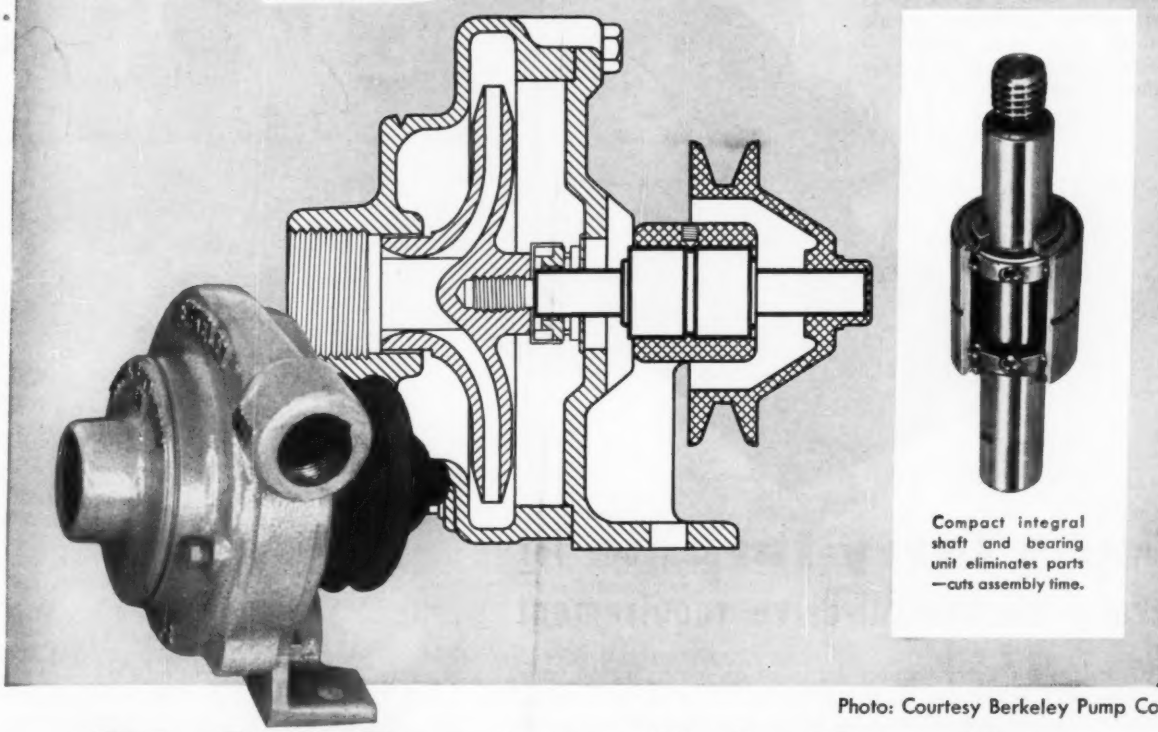

Photo: Courtesy Berkeley Pump Co.

N/D Ball Bearings Help Cut Size... Lower Costs $2.50 Per Pump!

CUSTOMER PROBLEM:

Redesign utility water pump for Air Conditioner market. Conversion must achieve smaller size without reducing pump capacity. At the same time, customer must lower over-all production costs.

SOLUTION:

N/D Sales Engineer suggested the versatile New Departure fan and pumpshaft ball bearing. This compact precision bearing permitted use of over-the-housing pulleys with belt load located over the raceway. Its integral shaft, which is the inner race, simplified design and helped reduce housing size without changing pump capacity. In addition, the sealed and lubricated-for-life bearing replaced two sealed bearings, separate shaft and snap rings . . . cutting part and assembly-time costs $2.50 per pump.

Perhaps one of New Departure's wide selection of *production* ball bearings will help give *your* product the sales appeal and cost savings you're looking for. For more information, call the New Departure Sales Engineer in your area or write Dept. U-11.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

MECHANICAL
ENGINEERING

PUBLISHED BY
THE AMERICAN SOCIETY OF
MECHANICAL ENGINEERS

Contents

VOLUME 80 • NUMBER 11 • NOVEMBER, 1958

THE COVER

Snug housing for Commonwealth Edison's Dresden atomic reactor, the $45 million General Electric project (50 miles SW of Chicago) to produce 180,000 kw when it begins operation in 1960. The Chicago Bridge and Iron Company designed, fabricated, and erected the 190-ft steel sphere, welding sections on a convex-concave turntable. Against possible malfunction, the shell must be airtight, capable of withstanding 29½ psi. Test procedure: Pressure — plus soap and water, men searching seams of the great sphere for bubbles.

Contents continued on following page

MECHANICAL ENGINEERING

PUBLISHED BY
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Contents (continued)

VOLUME 80 • NUMBER 11 • NOVEMBER, 1958

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58,000 copies of this issue printed

MECHANICAL ENGINEERING
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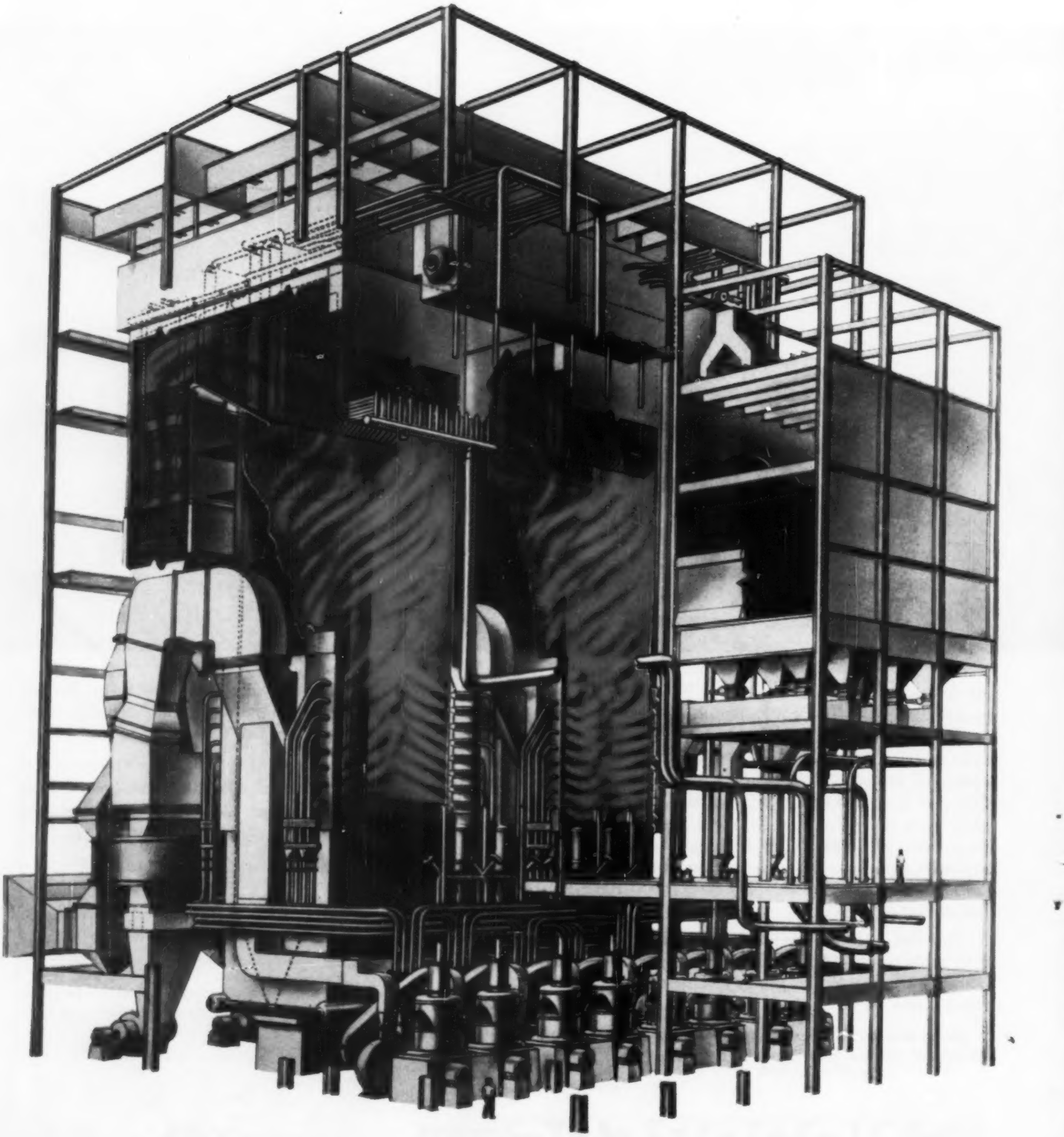
Departments

C-E earns an
in the 2400 psi



C-E CONTROLLED CIRCULATION TWIN-FURNACE BOILER

Controlled circulation units of the twin or divided furnace type have amply demonstrated their suitability for high-pressure, high-capacity requirements.

overwhelming preference throttle pressure range

Recent years have seen a marked trend toward the use of the 2400-lb *throttle* pressure, and indications are that this will be the prevailing pressure for units in the 200 MW-up class for some time to come.

The following list of C-E Boilers installed, under construction or on order, reveals the *extent of Combustion's experience* in the design, manufacture and operation of 2400-lb boilers. The total electric generating capacity of these boilers (6,592,000 kw) accounts for well over half of *all* the 2400-lb capacity ordered to date by American utilities.

Another significant aspect of present American practice in this pressure area is the recognition of the C-E Controlled Circulation Boiler as *the design best suited to use of the 2400-lb cycle.* The extent of this recognition may be judged from the fact that 30 of the 33 units listed are of this design. The other 3 are C-E Sulzer Monotube Steam Generators.

C-E Boilers* for 2400-lb Throttle Pressure

COMPANY	STATION	NO. OF UNITS	STEAM TEMP. F	CAPACITY—kw TOTAL
Central Hudson Gas & Electric Corp.	Danskammer	2	1050/1000	250,000
Cincinnati Gas & Electric Co.	Beckjord	1	1055/1005	156,250
Cincinnati Gas & Electric Co.	Miamifort	1	1055/1005	156,250
Cleveland Electric Illuminating Co.	Eastlake	1	1050/1050	187,500
Cleveland Electric Illuminating Co.	Ashtabula	1	1050/1050	225,000
Consumers Power Co.	Dan E. Karn	1	1050/1050	250,000
Consumers Power Co.	Port Sheldon	2	1050/1000	500,000
Dayton Power & Light Co.	Tait	2	1050/1000	260,000
Detroit Edison Co.	St. Clair	1	1050/1000	325,000
Duke Power Co.	Allen	2	1050/1000	330,000
Duke Power Co.	Allen	2	1050/1000	550,000
Duke Power Co.	Lee	1	1050/1000	165,000
Metropolitan Edison Co.	Portland	1	1050/1050	165,000
Niagara-Mohawk Power Corp.	Huntley	2	1050/1000	400,000
Niagara-Mohawk Power Corp.	Dunkirk	2	1050/1000	400,000
Pennsylvania Electric Co.	Shawville	2	1050/1000	330,000
Pennsylvania Power & Light Co.	Brunner Island	1	1005/1005	300,000
Philadelphia Electric Co.	Schuylkill	1	1050/1000	175,000
Potomac Electric Power Co.	Dickerson	2	1050/1000	350,000
South Carolina Electric & Gas Co.	McMeekin	2	1050/1000	250,000
Tennessee Valley Authority	Widows Creek	1	1053/1003	500,000
Virginia Electric & Power Co.	Chesterfield	1	1000/1000	167,000
Virginia Electric & Power Co.	Possum Point	1	1000/1000	200,000

*The above list covers American utilities only. Abroad, too, the C-E Controlled Circulation Boiler has achieved a predominant position for 2400-lb applications, evidenced by orders placed with C-E or its licensees for 21 units with an aggregate capacity of 5,270,000 kw.

COMBUSTION ENGINEERING

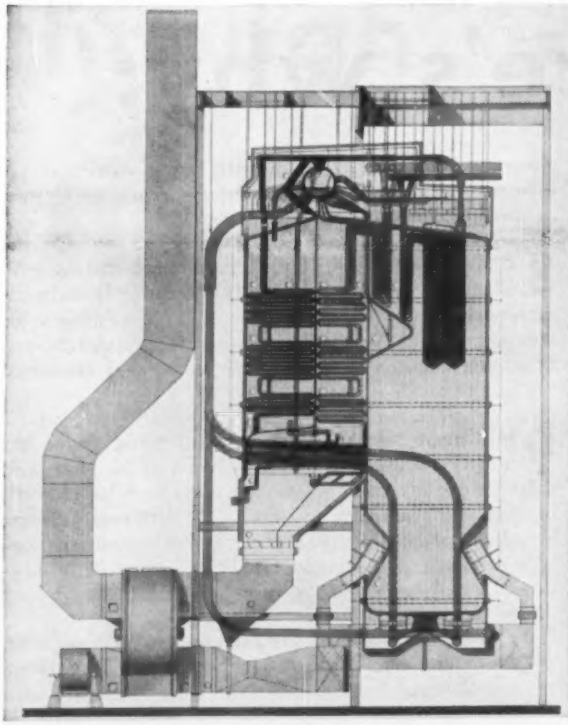
C-E

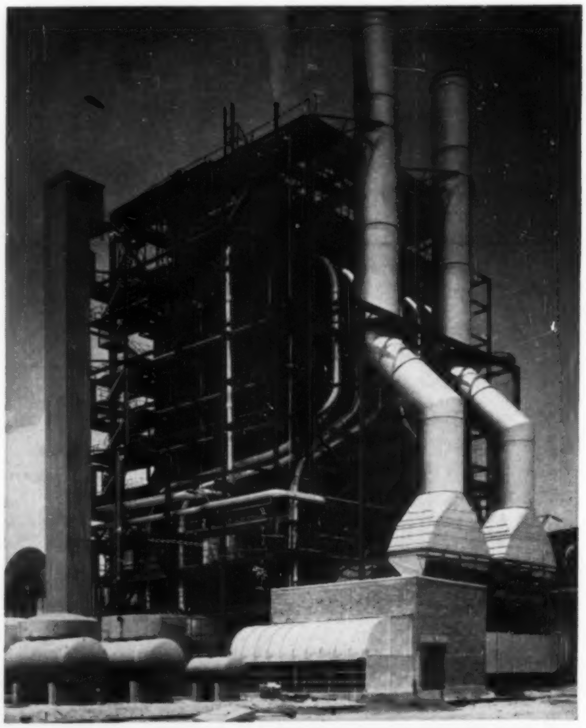
C-181

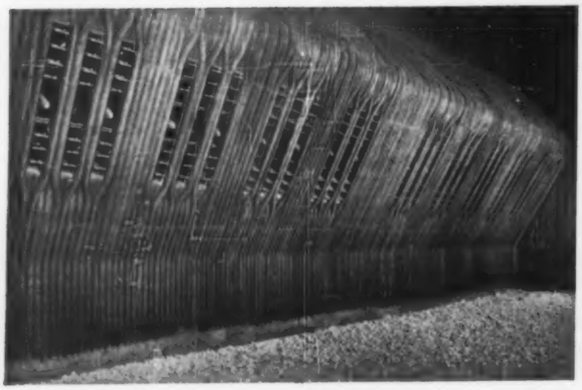
Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

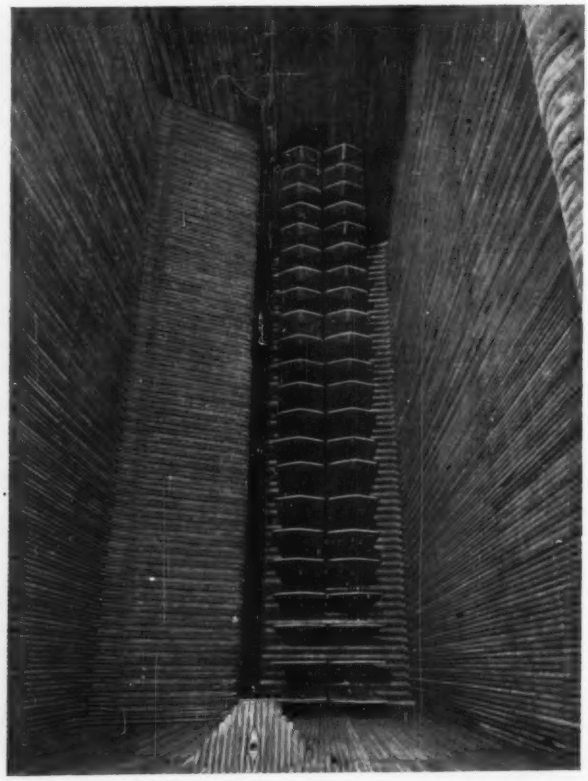
ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

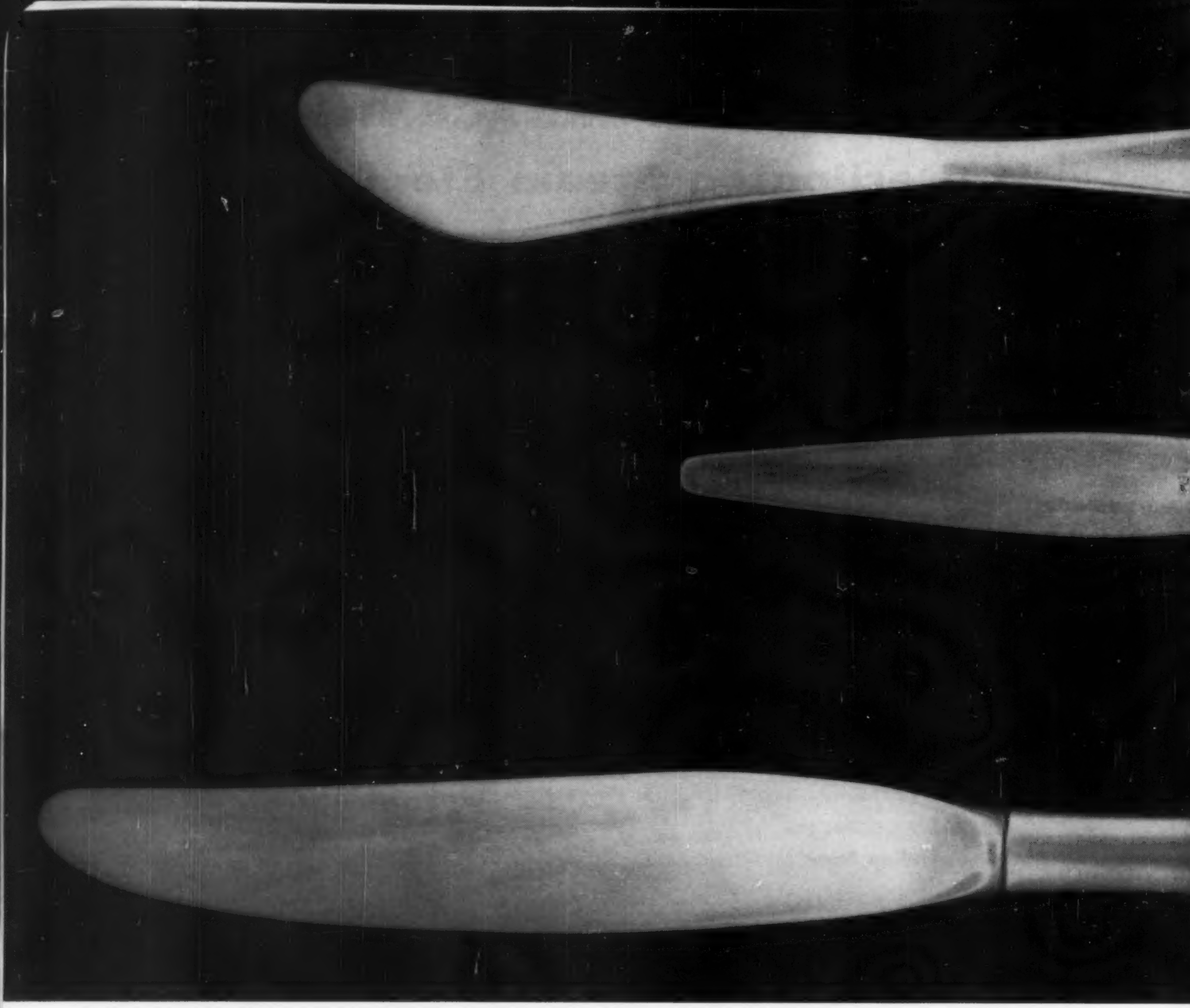
Performance

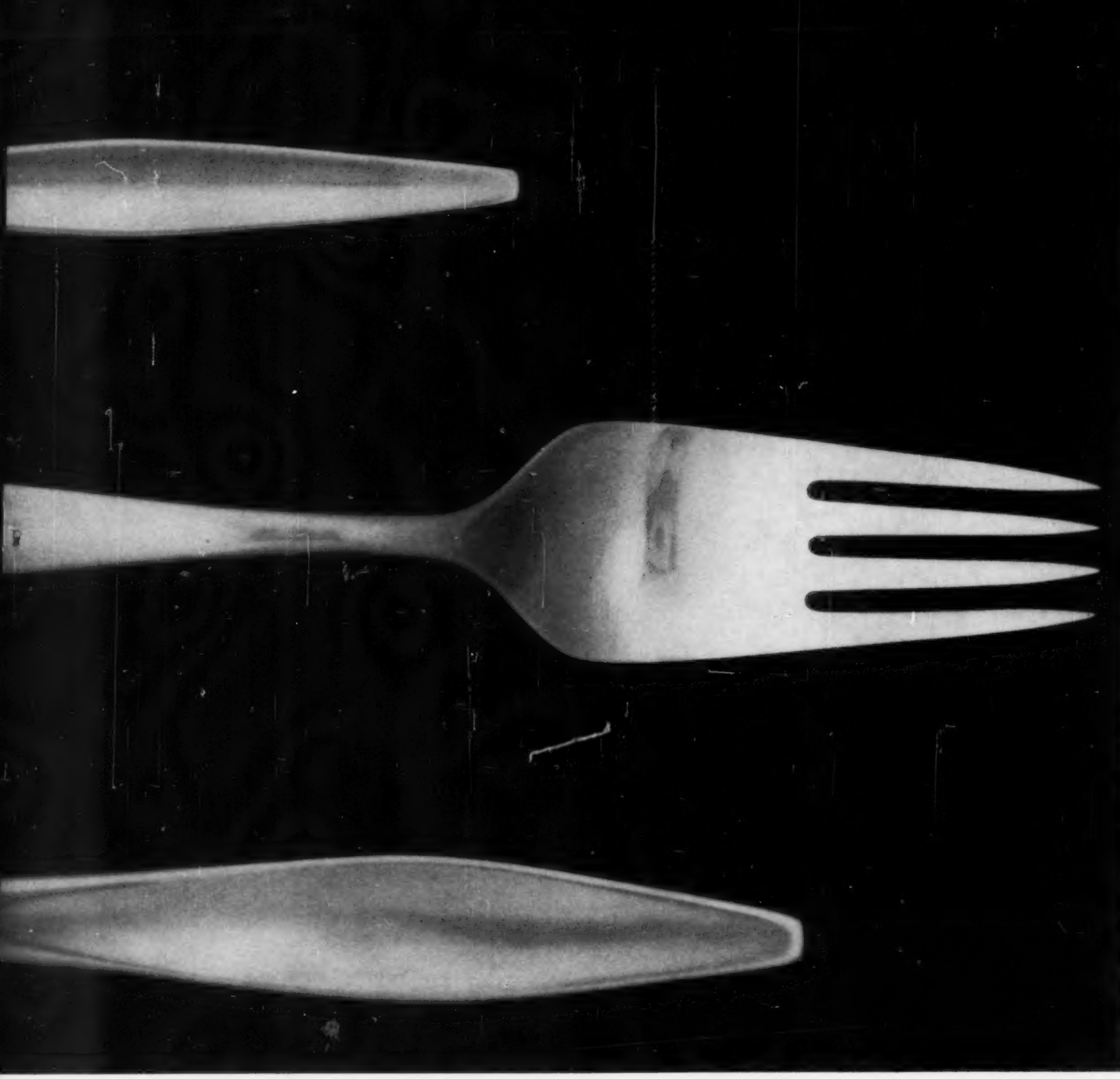




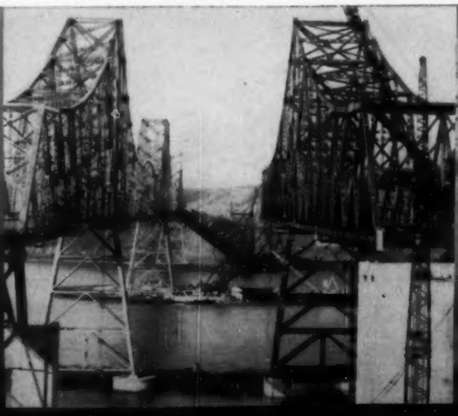


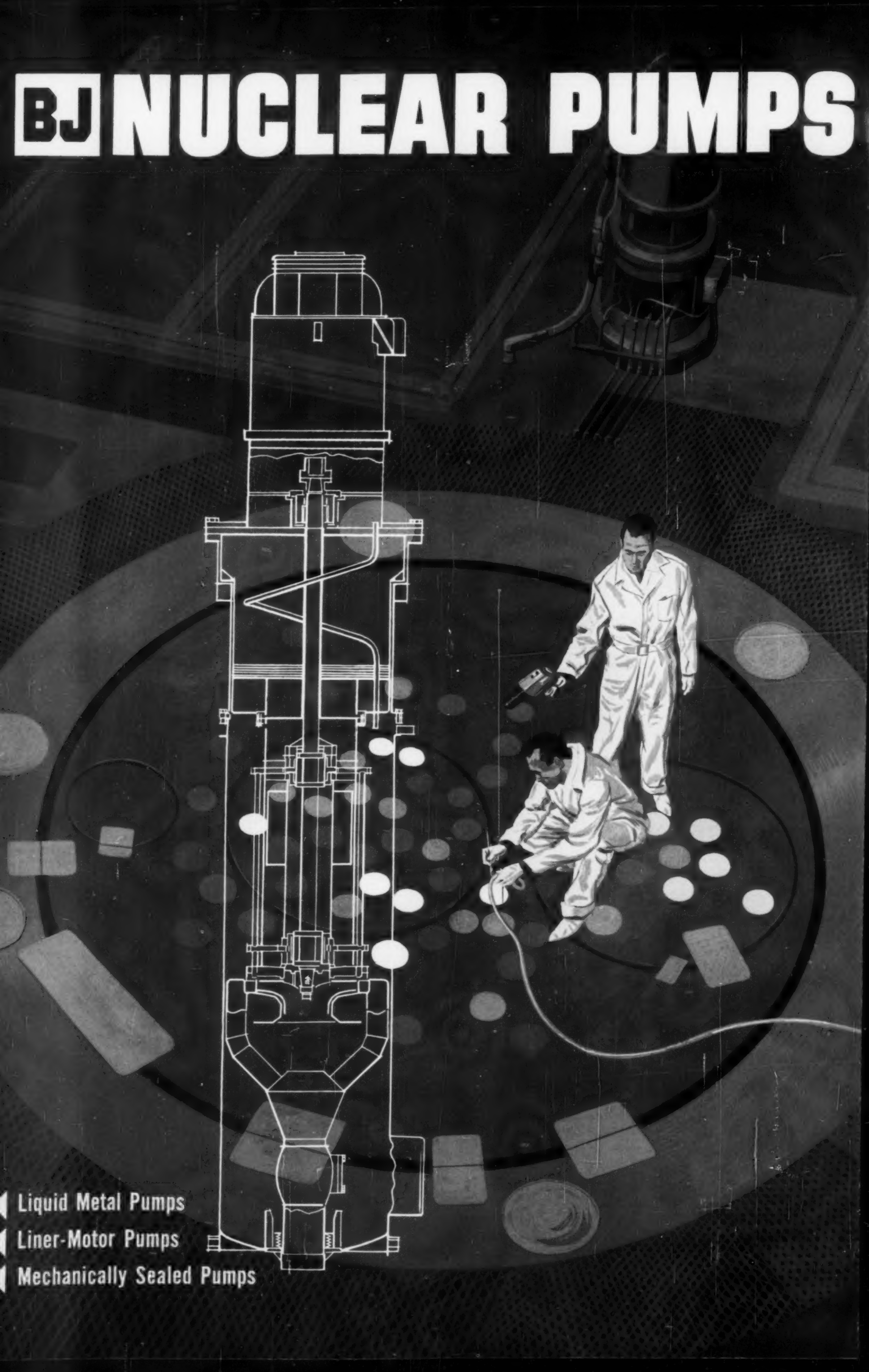




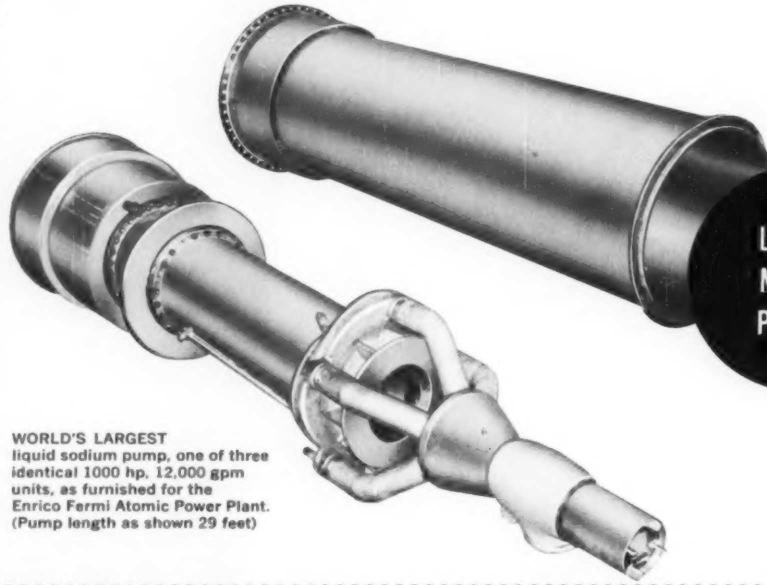



IO E 2782




BJ NUCLEAR PUMPS
Liquid Metal Pumps
Liner-Motor Pumps
Mechanically Sealed Pumps

PULL FOR YOUR FILE



WORLD'S LARGEST
liquid sodium pump, one of three identical 1000 hp, 12,000 gpm units, as furnished for the Enrico Fermi Atomic Power Plant. (Pump length as shown 29 feet)

LIQUID METAL PUMPS

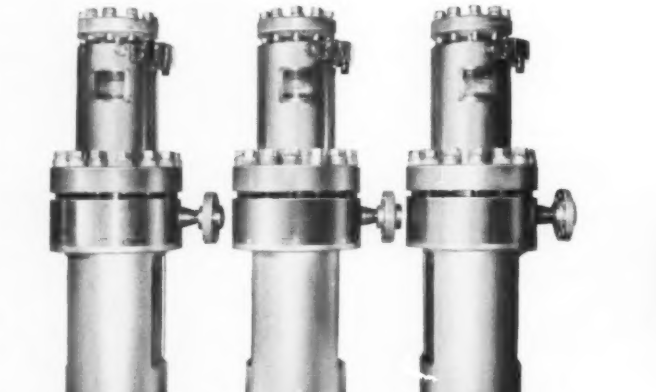
Byron Jackson's lea
of various pump designs
metals. While the pump
pressure and the capacit
maximum economy and

Using an inert-gas
maintain zero gas leakag

Other zero leakage
motor-pump units—with

BJ Liquid Metal Pu
to 1600°F., and pressure

Two
sho



Three of six BJ Liner-Motor pumps for the National Reactor Testing Station, AEC, Idaho Falls.
Rated at 30 hp, 2500 psig, 650°F.

LINER-MOTOR PUMPS

BJ offers a complete
engineered and manufac
and experimental loop te

The same basic desi
Liner-Motor pumps—wit
long, reliable service and

Available in complet
5100 psig and temperatu

500
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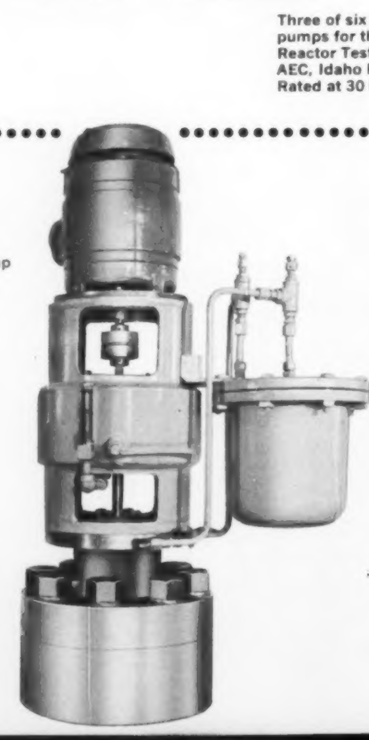
Rate

A BJ Mechanically-Sealed Pump furnished to Argon National Laboratories for 2500 psig, 650°F. service.



MECHANICALLY-SEALED PUMPS

A mechanical seal is
leakage and peak efficien
reliable shaft seal for use

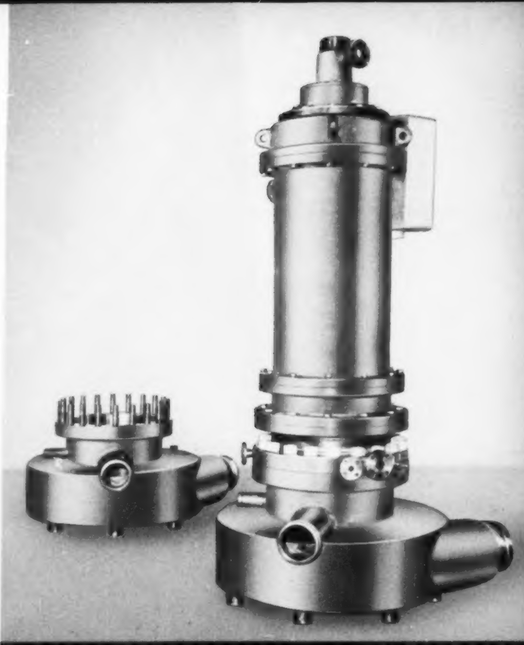
Byron Jackson's long
particularly valuable, with
2500 psig and temperatur

A ho
Insta
120C

BJ
SINCE 1872

adership in the pumping of liquid metals has led to the development
s for handling liquid sodium, lead, bismuth and other molten
p for a given job depends upon system geometry, temperature,
ities required, a BJ vertical, mechanically-sealed pump can provide
l reliability.
back up, this design incorporates a BJ Mechanical Seal to
ge to atmosphere.
designs for liquid metals include hermetically sealed,
n either oil or gas filled motors.
umps are available in capacities from 10 to 50,000 gpm, temperatures
es as required.

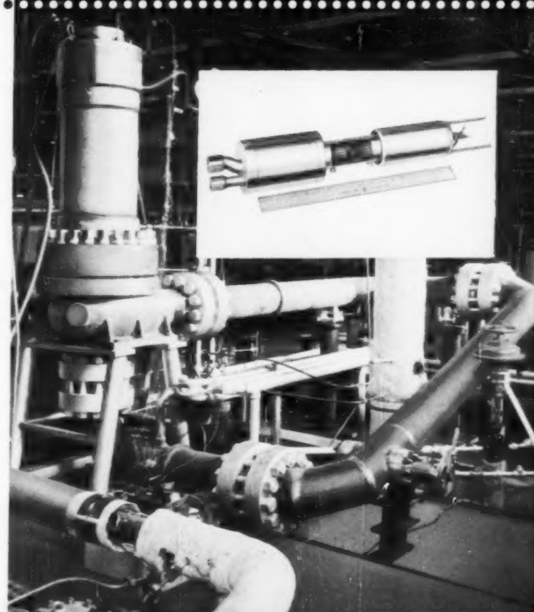
vo of six similar BJ Liquid Metal Pumps built for 1500°F. service. The units
own are rated at 700 hp, 4000 gpm.



e line of hermetically-sealed, integral liner-motor pumps—
ctured for the demands of zero leakage in nuclear power service
esting.
sign and heavy-duty construction is furnished on all BJ
th even the smallest sizes featuring double thrust bearings for
d operation in any position.
ete range of sizes from 1/4 to 600 hp, and with pressures to
res to 700°F.

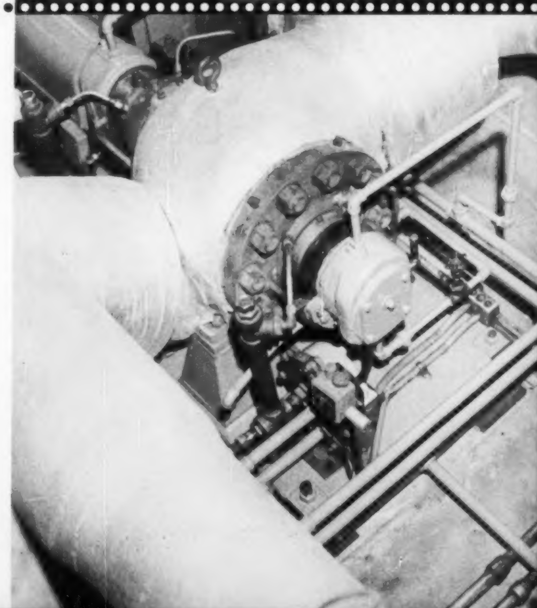
0 hp liner-motor pump ready for hot test on one of the BJ test loops. Pump
ated at 650°F., and 2500 psig.

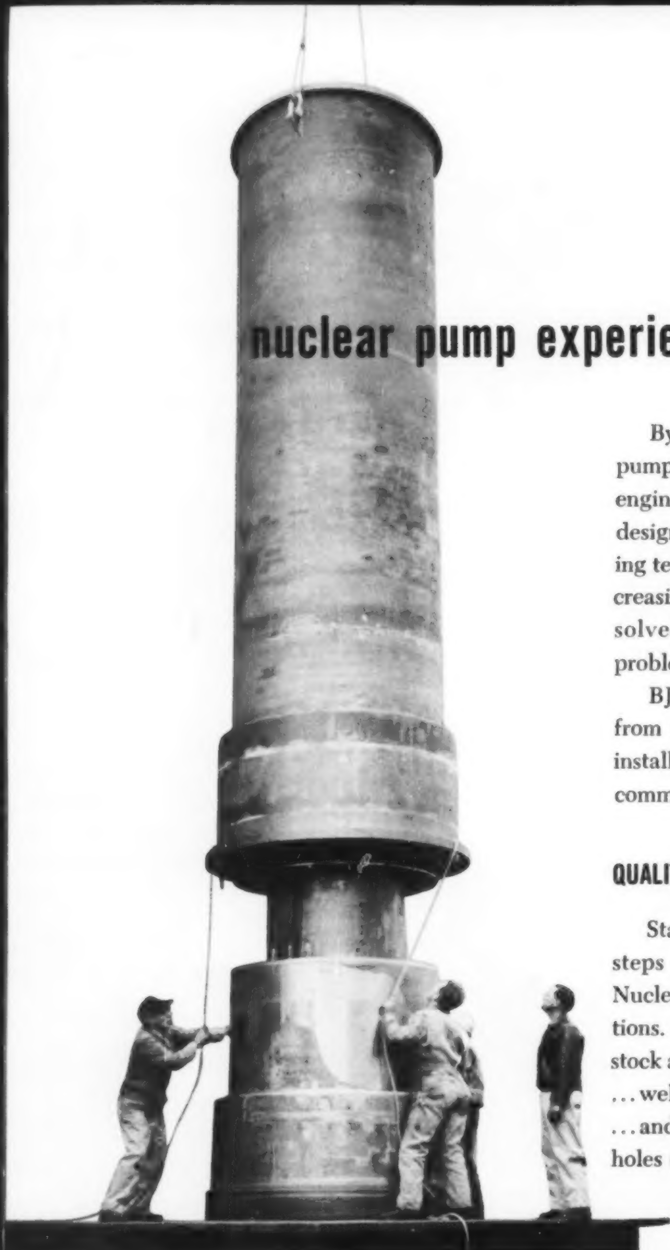
set) This compact, two-stage BJ Pump was developed for an extremely limited
ce application, handling uranium sulphate at system pressures of 2000 psig.
ed at 1/4 hp, 3500 rpm and 600°F.



the most economical means of combining minimum controlled
cy in nuclear pumping. It can now be considered as a completely
in primary circulating pumps of full scale power reactors.
g experience in building mechanically-sealed pumps can be
h current nuclear pumps of this type operating at pressures up to
res to 650°F.

orizontal, mechanically-sealed BJ Pump driven by a standard motor.
alled at Canadian General Electric, it is designed for heavy water under
0 psig suction pressure, 600°F. temperatures.





nuclear pump experience you can count on...

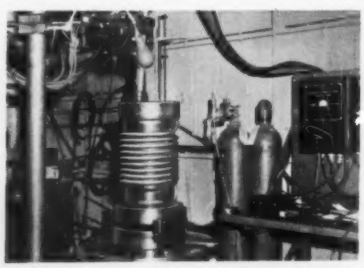
Byron Jackson's authority in the field of nuclear pumping comes from over 86 years of continuous engineered pump-building experience. The basic design, metallurgy, engineering and manufacturing techniques perfected by BJ in meeting the increasing demands of industry over the years have solved many of the unique nuclear pumping problems.

BJ's actual nuclear pump experience dates from 1944, and as a result, BJ Pumps are either installed or have been specified for every major commercial reactor in the United States.

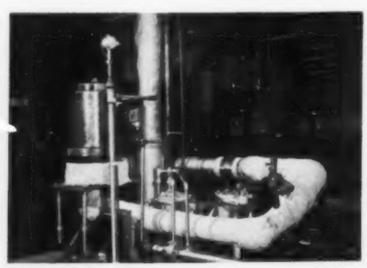
QUALITY CONTROL

Starting with material selection, through all steps of construction and final inspection, BJ Nuclear Pumps must meet or exceed all specifications. Ultrasonic quality plate, forgings and bar stock are used... castings are radiographic quality ... welds are x-ray quality with inert gas back-up ... and internal surfaces are free of roughness, pin holes or protrusions.

Typical of BJ's quality control facilities is this helium mass spectrometer, shown leak testing a liner-motor pump.



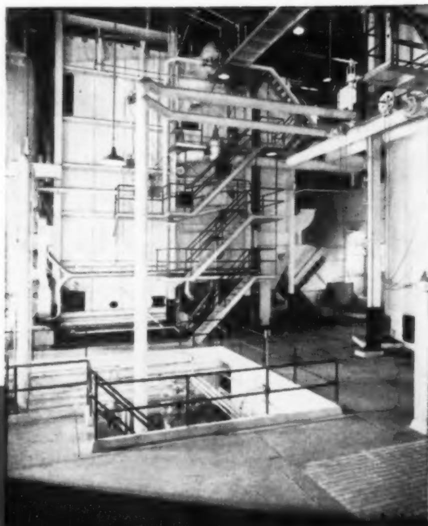
Maximum welding quality, as well as production efficiency, is assured with equipment such as this automatic, inert-gas welding head on a movable platform.



Pumps are hydraulically and hydrostatically tested to rated conditions in BJ's own laboratory. Hot and cold loop testing facilities to 10" are provided, with the 4" hot loop shown.

BJ
SINCE 1872

BYRON JACKSON PUMPS
INCORPORATED
A subsidiary of Borg-Warner Corporation
P. O. Box 2017A, Terminal Annex
Los Angeles 54, California



2—150,000 #/hr. Erie City 2-drum Steam Generators, stoker fired, at GREAT WESTERN SUGAR CO., Longmont, Colorado

2—70,000 #/hr. Erie City 2-drum Steam Generators, oil and gas fired, at INTERNATIONAL BUSINESS MACHINES CORP., Rochester, Minnesota

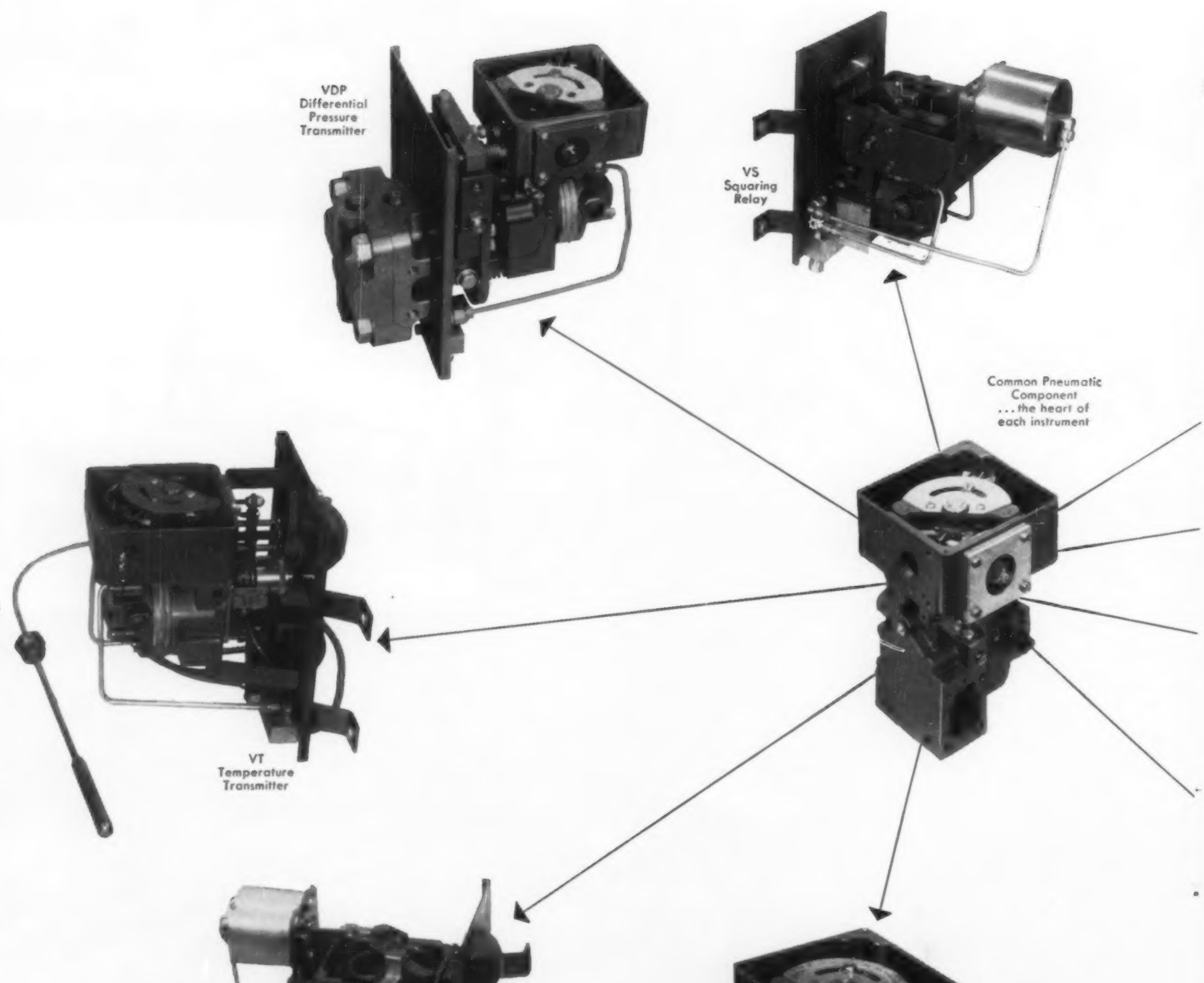
1—150,000 #/hr. Erie City 2-drum Steam Generator, oil and gas fired in a pressurized furnace, at THE TEXAS CO., Lockport, Illinois

2—65,000 #/hr. Erie City 2-drum Steam Generators, stoker fired with coal and wood waste, at JOHNS-MANVILLE PRODUCTS CORP., Klamath Falls, Oregon

1—50,000 #/hr. Erie City 2-drum Steam Generator, gas fired, at DIERKS PAPER CO., Pine Bluff, Arkansas

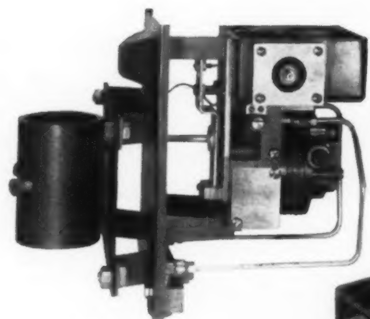
Rockwell-Built REPUBLIC

serve any process,

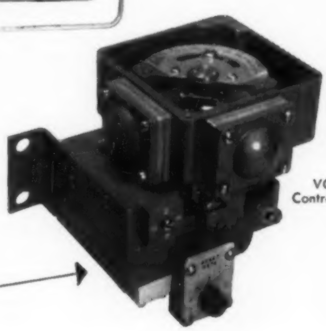


VECTOR SERIES INSTRUMENTS

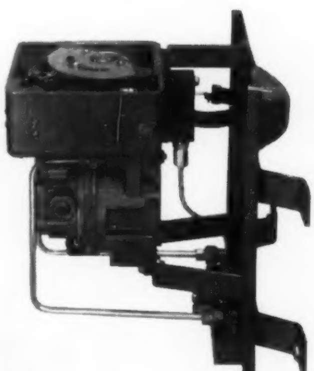
cut costs too!



Bellows Type VP Pressure Transmitter



VC Controller



Bourdon Tube VP Pressure Transmitter

VRR Ratio Relay

You can save substantial money when your control systems are based on Republic's Null-Balance Vector instruments. Each has as its "heart" an identical pneumatic component, with obvious advantages. Among these are interchange of parts, even among instruments performing entirely different functions. Besides involving a minimum spare parts inventory, this feature greatly simplifies personnel training.

Components shown demonstrate the depth of the Republic line. Differential pressure transmitters with 20-to-1 range adjustment . . . temperature transmitters with 10-to-1 range adjustment . . . pressure transmitters of ±0.5% accuracy. We have ratio, totalizing, multiplying, squaring and square root extracting relays. Our all-purpose controllers feature proportional band adjustment of 2% to 500% and reset adjustment from 0.1 to 50 repeats per minute.

The Republic Engineer in your area will be glad to work with you on any control or measurement problem. Sales offices in principal cities throughout the United States and Canada. Call or write—with no obligation, of course—*Republic Flow Meters Company*, 2240 Diversey Parkway, Chicago 47, Illinois (subsidiary of Rockwell Manufacturing Company). In Canada: Republic Flow Meters Canada, Ltd., Toronto.

REPUBLIC INSTRUMENTS AND CONTROLS

more fine products by

ROCKWELL

POPPET TYPE VALVE

(WITH ADJUSTABLE PRESSURE CONTROL)

additional important features of the

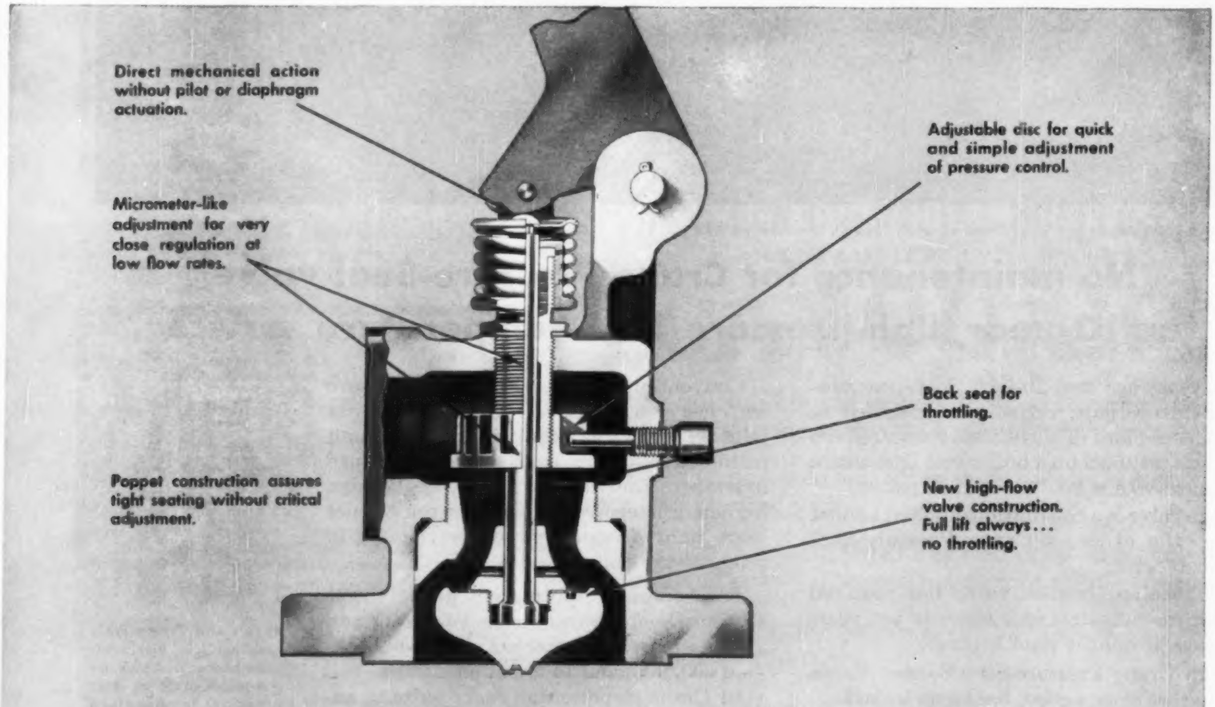
New Diamond Series 300 IK

LONG RETRACTING BLOWER

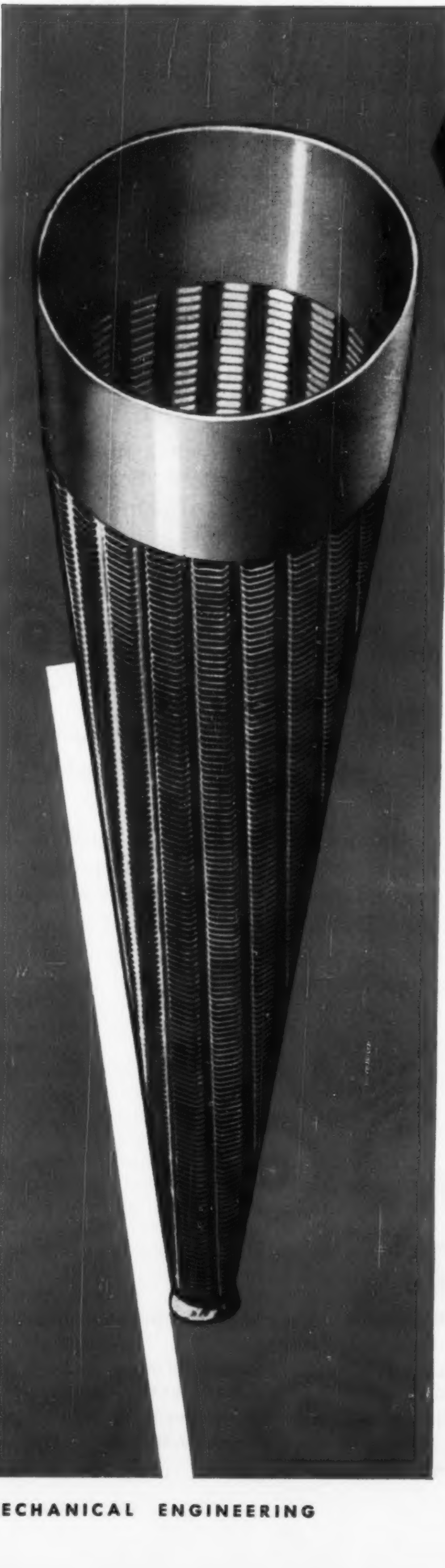
This valve was adopted for the new Series 300 IK because long experience has proved it the most satisfactory of all designs for severe blower service. More than 300,000 of this basic design are in use on various Diamond Blowers and have established notable service records. A recent improvement is more streamlined flow contours that permit higher flow rates with less pressure drop.

The direct mechanical linkage for actuating the valve offers the advantages of greater reliability and safety . . . in addition to more accurate control. Numerous other important features of the Series 300 IK are listed at the bottom of the left hand page. These are the reasons why this blower is establishing a new standard of efficiency, economy and dependability in cleaning heating surfaces that require a long retracting blower.

Bulletin 2111 AA tells much more about the Series 300 IK; ask your local Diamond office or write directly to Lancaster for a copy.



FULL LIFT AND FULL OPENING OF VALVE AT ALL TIMES. No throttling at main seat. ALL throttling for pressure control is between back seat and adjustable disc.



with this *INSTALLATION*

TURBO-BLOWER blade wear is... *CHECKED!*

With this Green AERODYNE Dust Collector, turbo-blower blade wear is sharply reduced.

Green AERODYNE Dust Collectors reduce coke breeze, coal dust, ferrous oxides and other abrasive dusts that wear out high-speed turbo-blower blades.

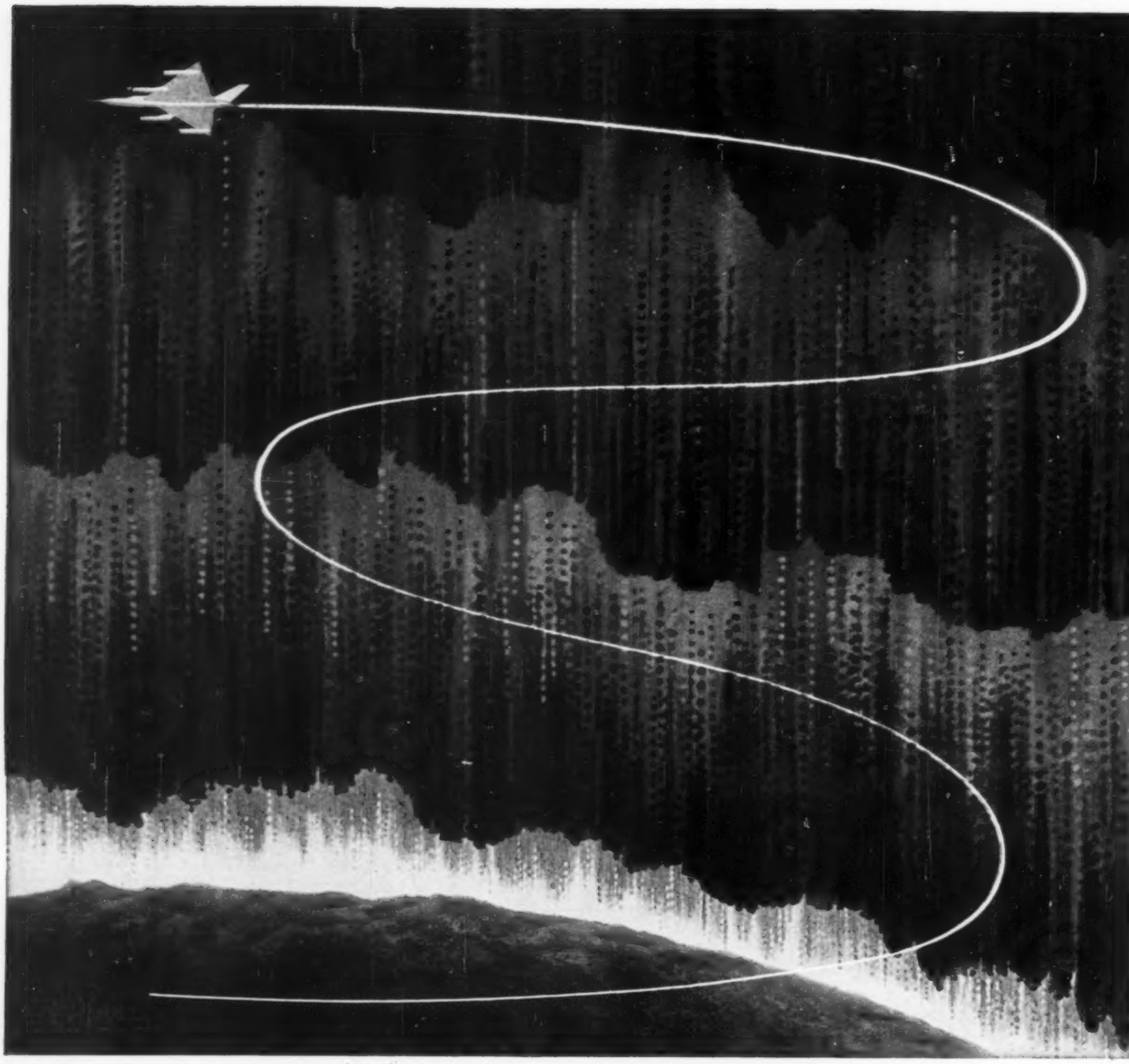
AERODYNE Dust Collectors are also used to clear combustion air for gas turbines. Oil bath and other types of filters requiring constant maintenance are eliminated by AERODYNE, as the collected dust is returned to the atmosphere. Dust disposal problems are eliminated.

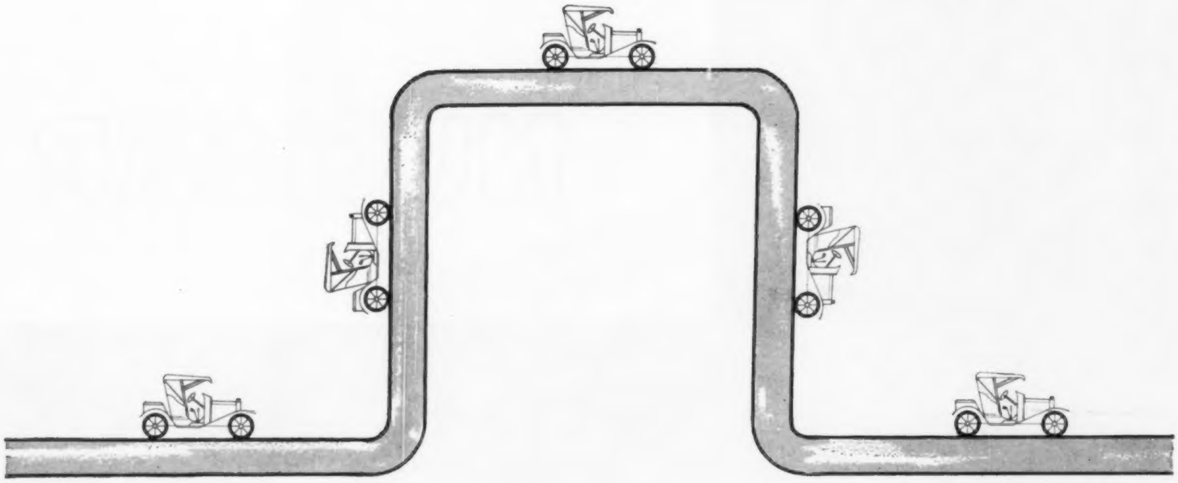
You will find this wear-reducing story of interest. A word to Green will bring you the details.

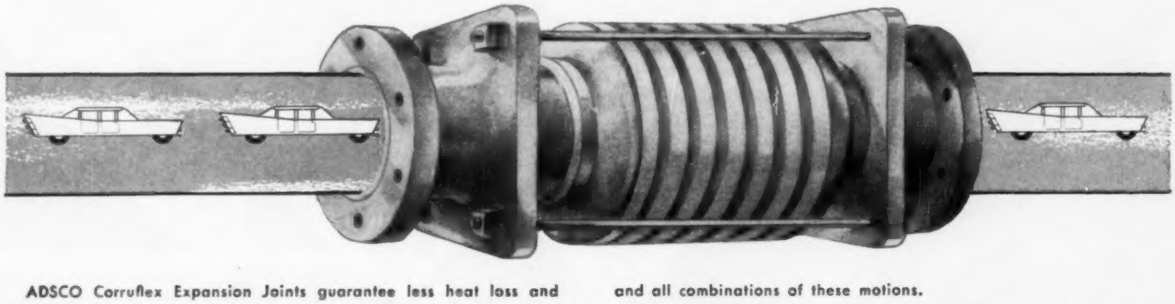
Green

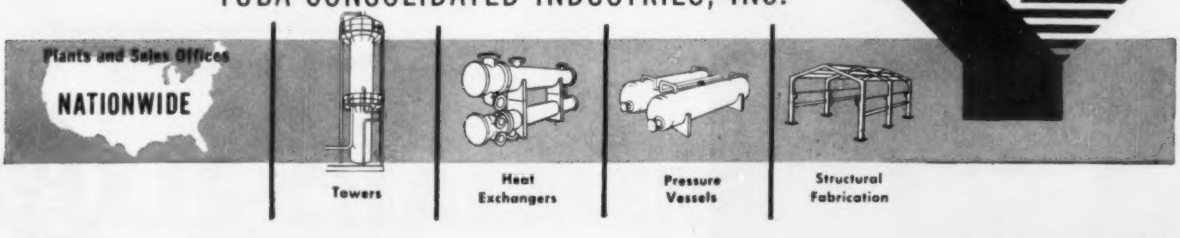
THE GREEN FUEL ECONOMIZER CO., INC.

BEACON 3, NEW YORK



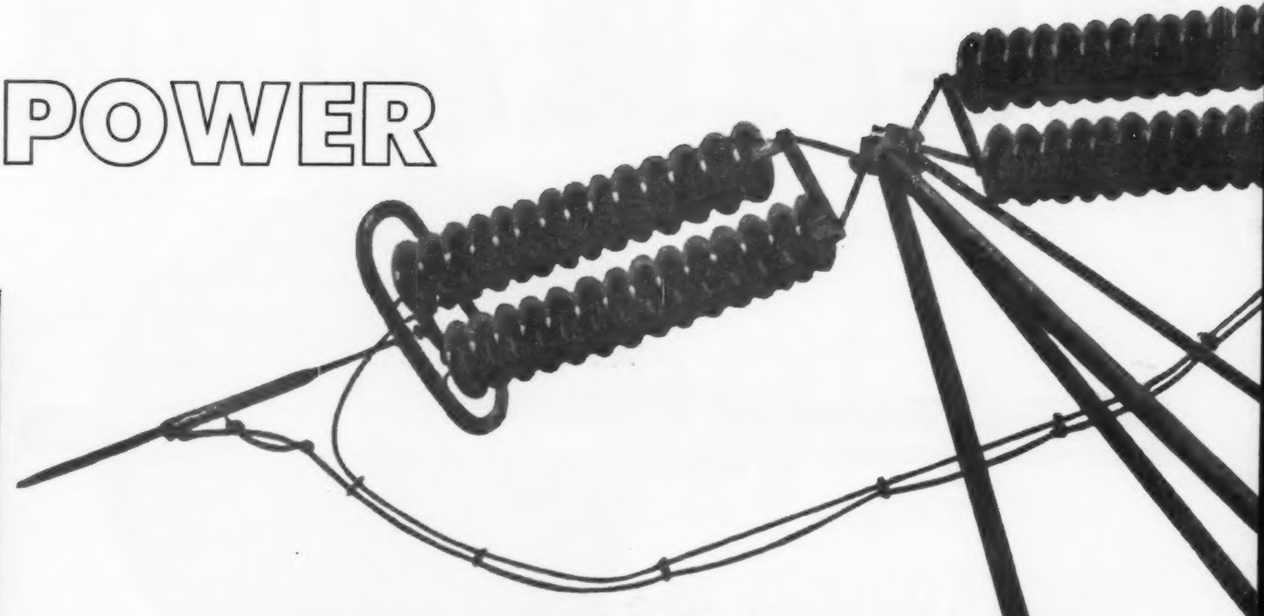






Plants and Sales Offices
NATIONWIDE
Towers
Heat Exchangers
Pressure Vessels
Structural Fabrication

POWER



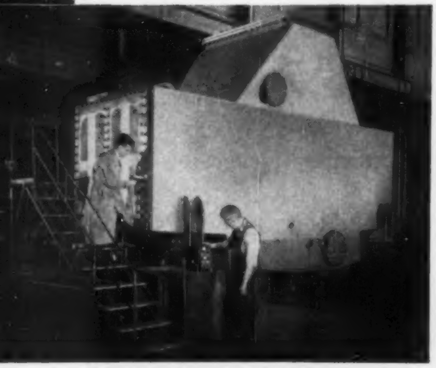
Power equipment backed by
15 years of nuclear engineering experience

Allis-Chalmers development of nuclear reactors and allied equipment is a logical outgrowth of 75 years of building basic power equipment.

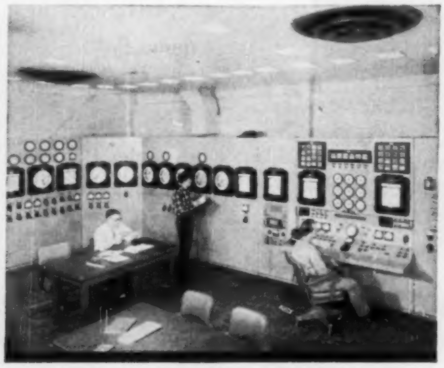
With nuclear experience dating back to the Manhattan Project, facilities, engineering, and production skills are being utilized to produce nuclear power equipment with the same high standards that identify A-C steam turbine generators, condensers, pumps, water conditioning equipment, control, switchgear, breakers, and transformers.

Allis-Chalmers is now engaged in the design and will construct a 66,000-kilowatt nuclear power plant* for the Northern States Power Company in cooperation with ten other electric companies.

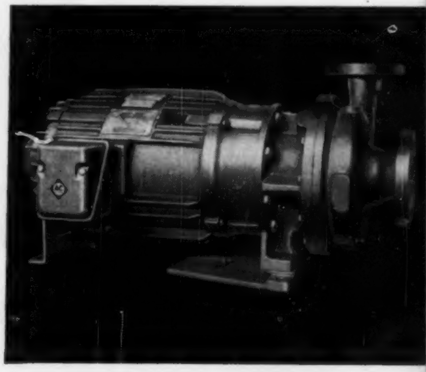
Equipment and engineering for all nuclear power plant needs . . .



Condensers



Control and Switchgear

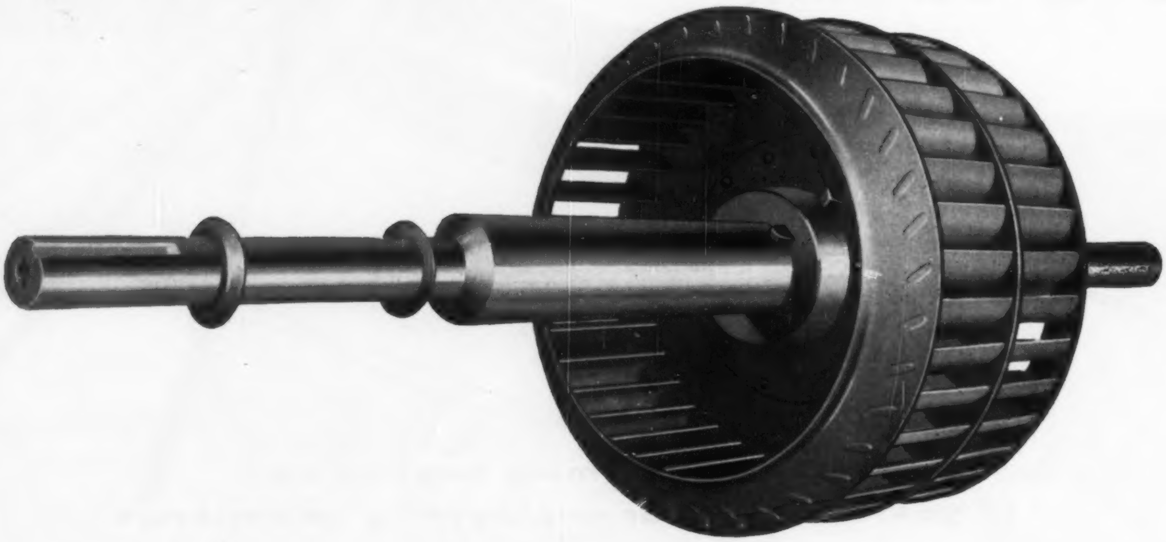


Nuclear Pumps

ALLIS-CHALMERS

*A model of a nuclear power plant using a Controlled Recirculation Boiling Reactor with nuclear superheater will be featured in the Allis-Chalmers exhibit in the United States Exhibition Area, Geneva Atoms for Peace Exhibition.

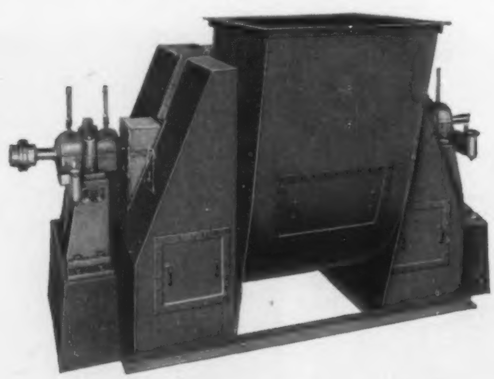
CLARAGE



Takes rough–tough jobs in stride . . . ADVANCED DESIGN DYNACURVE FAN

In the Clarage tradition of heavy-duty construction, here is induced draft equipment offering numerous advantages:

36 radially deep, aerodynamically curved blades impart dynamic energy to the gas stream which is effectively directed to achieve low tip speed operation.



Unique shape of blades and rims minimizes shock losses and turbulence, helps extend high efficiency over wide performance range, assures low moment of inertia (WR^2).

Advanced design of wheel and housing reduces floor space and height requirements for low first cost, low installation cost.

Special design and rugged construction of the wheel assures long service life and low maintenance cost.

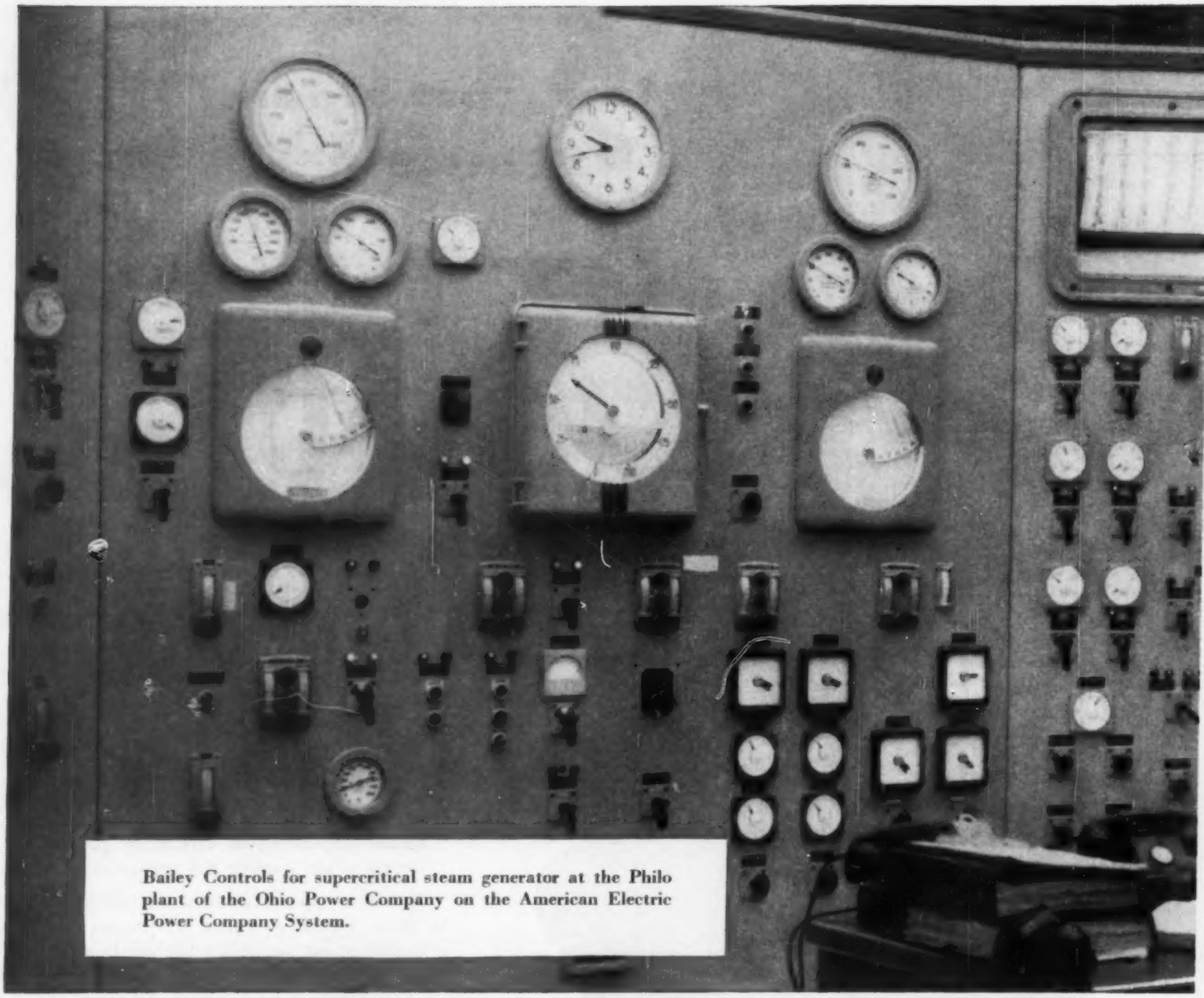
Learn more about this stand-out fan in the induced draft field. Request Catalog 905 covering Clarage Type DN Dynacurve Fans.

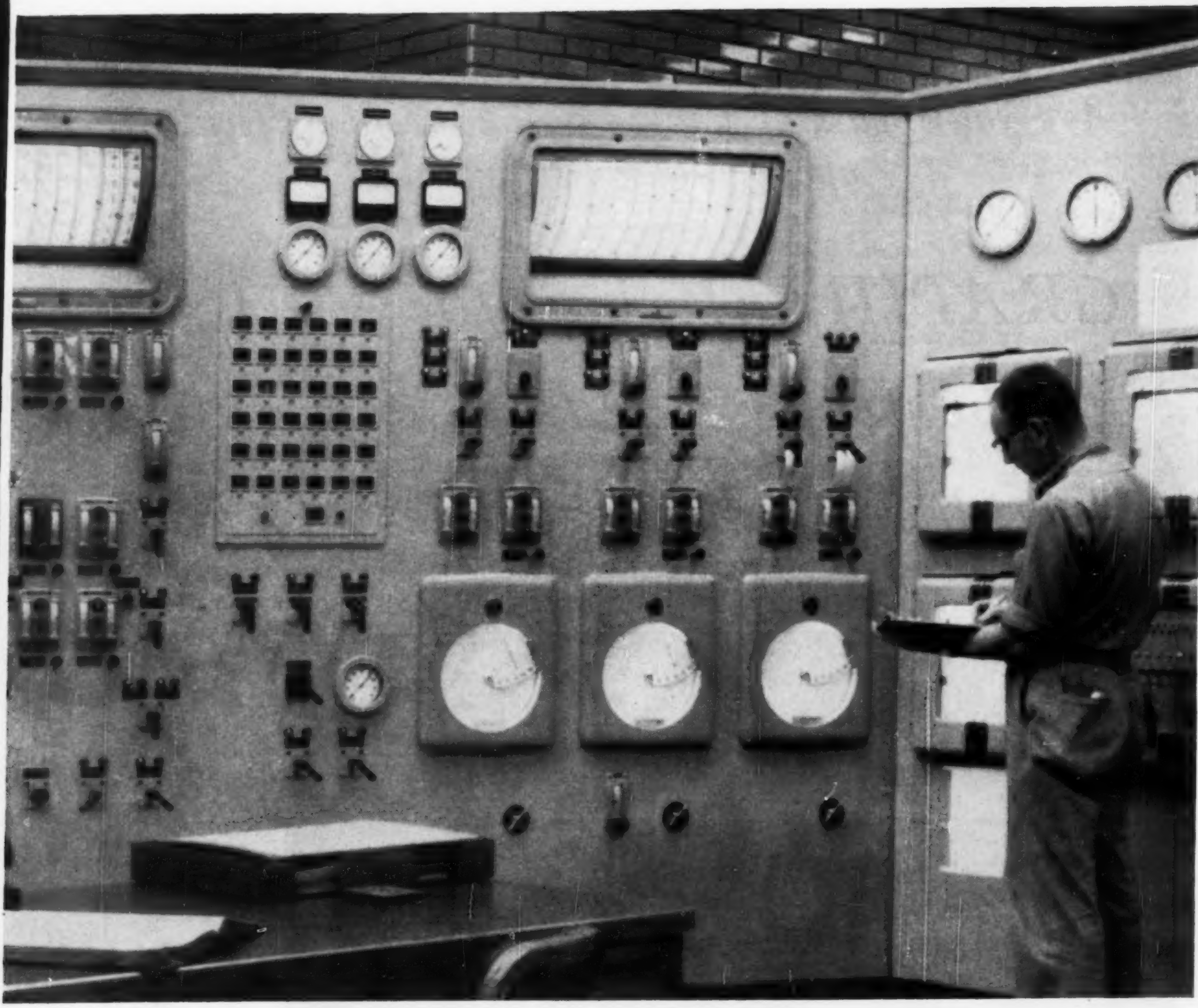
Dependable equipment for making air your servant

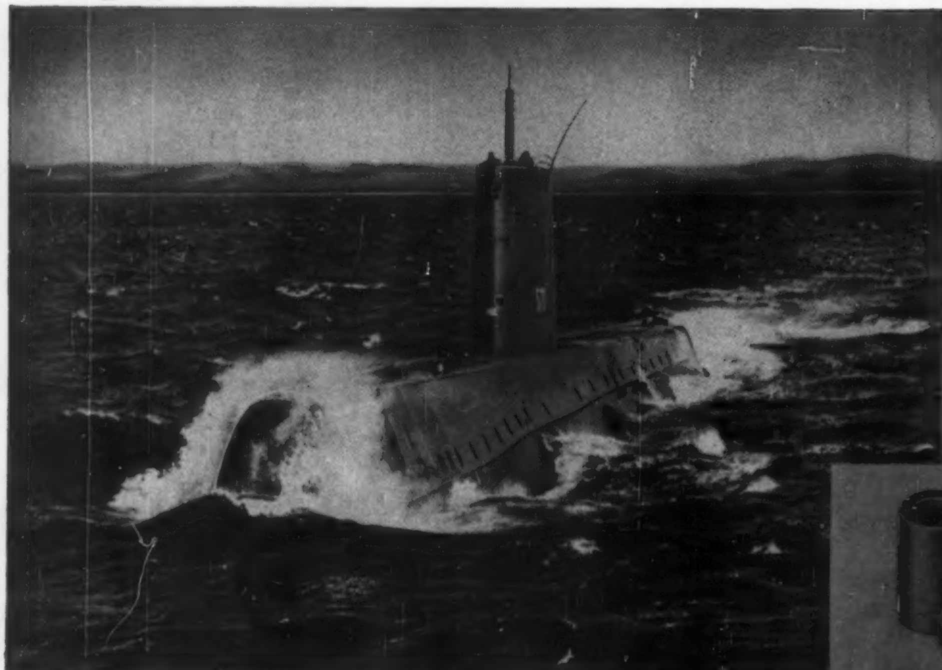
CLARAGE FAN COMPANY

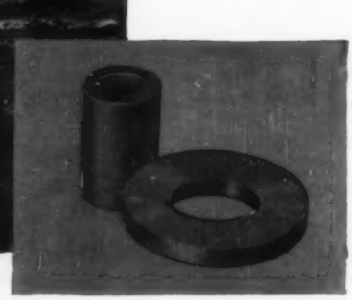
Kalamazoo, Michigan

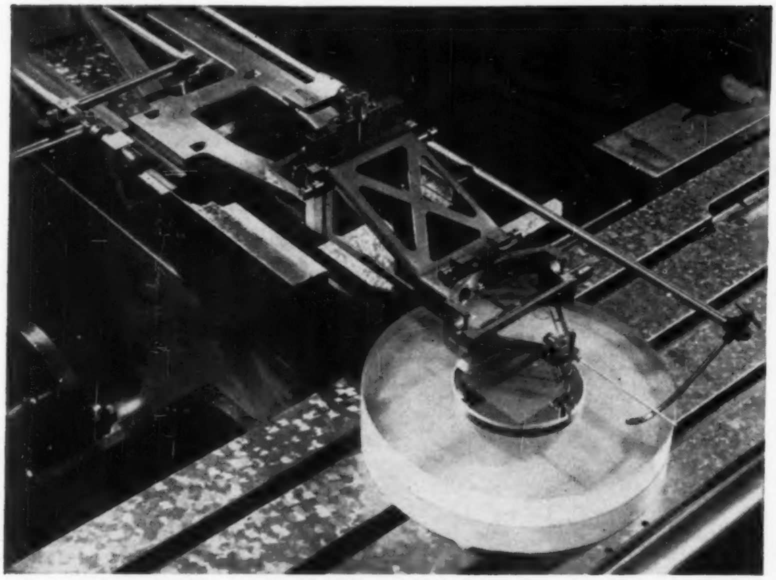
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



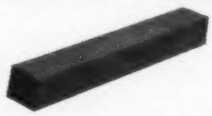






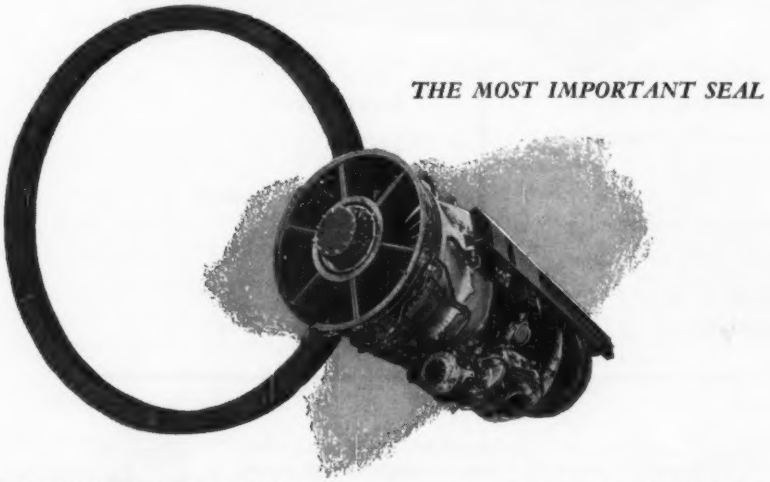


THE MOST EXACTING BEARING



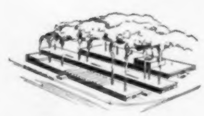
The Bausch & Lomb Optical Co. of Rochester, N.Y., world renowned manufacturer of precision, scientific optical instruments, employs 10 GRAPHITAR bearings in its unique and highly specialized "ruling engine." The GRAPHITAR bearings provide dimensional stability within one-millionth of an inch for micro-inch accuracy in cutting 15,000-30,000 equidistant lines to the inch on 7" aluminized glass blanks to make diffraction gratings used by science and industry for spectroscopic analysis. Bausch & Lomb engineers have found that GRAPHITAR is unsurpassed as a bearing material where very close tolerances must be maintained and where frequent starting and stopping under heavy loads is a problem. These bearings have contributed greatly to the achievement of extreme accuracy in this application. If you require precision performance as was the case with a "ruling engine" why not use GRAPHITAR?

THE MOST IMPORTANT SEAL



GRAPHITAR is the main shaft seal in the Pratt & Whitney J57 turbojet engine which powers many of our new aircraft, including the huge Boeing B-52 Intercontinental Bomber, which has eight of these turbojets. Naturally, the J57 must perform with utter dependability. One of the components of the J57 is the air/oil seal of GRAPHITAR on the turbine main shaft, and this seal is subjected to tremendous shaft speeds, as well as other taxing physical conditions. GRAPHITAR parts can stand severe operation because they are strong and are virtually unaffected by extremes of speed, pressure, and temperature. If your product develops high speeds or other difficult physical stresses on its parts, perhaps GRAPHITAR components could give it more dependable operation.

THE TOUGHEST APPLICATION



Steel mills are famous for the rough, tough, heavy-duty jobs that they perform. In such difficult steel mill applications as bearings for shear and cut-off tables or coil and slab conveyors, metal-backed GRAPHITAR parts provide exceptional strength and durability. GRAPHITAR alone is a very strong bearing material, and when backed with metal has added resistance to shock. Because of its very low coefficient of friction, GRAPHITAR can operate under heavy loads at high speeds with no lubrication. Can the strength and superb bearing qualities of GRAPHITAR simplify your product design?

Get your copy of Engineering Bulletin No. 20.

GRAPHITAR is compacted from carbon-graphite powders under great pressures, then furnaced at heats near 4500°F. It can be formed in relatively complex shapes and ground to tolerances as close as .0005". For more information on this strong, light, self-lubricating engineering material, write for our Engineering Bulletin No. 20.

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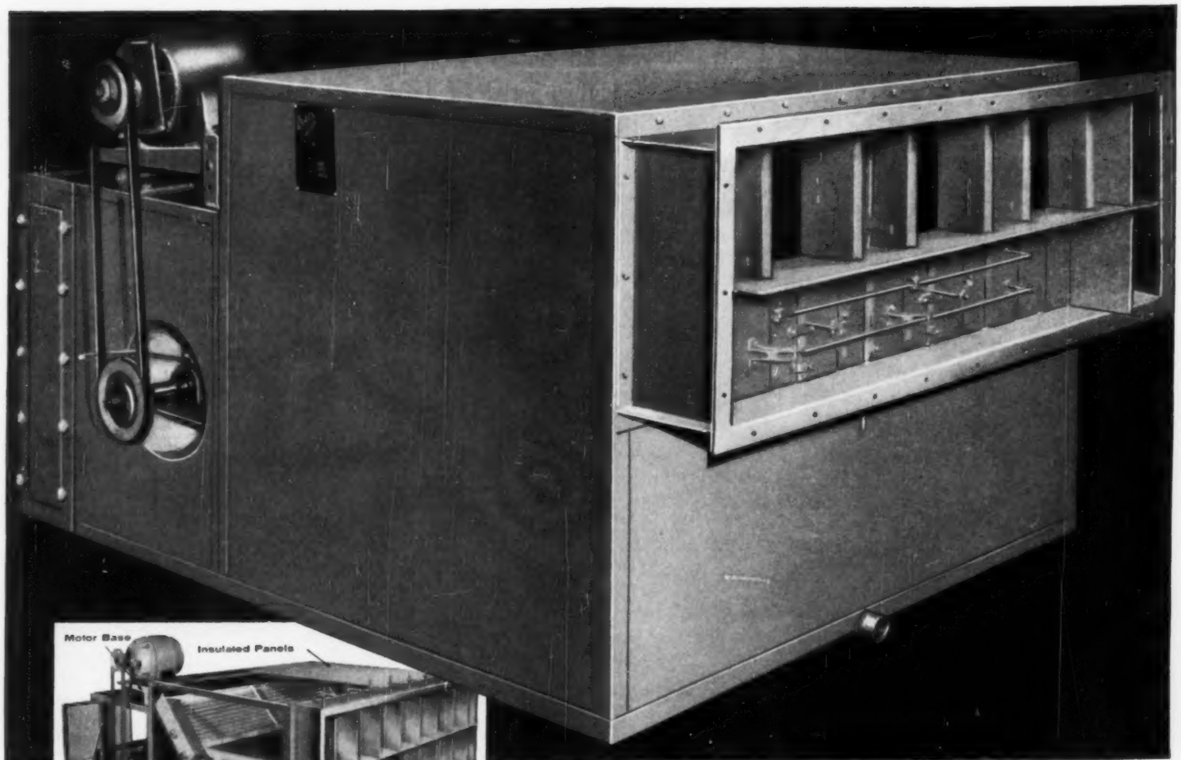
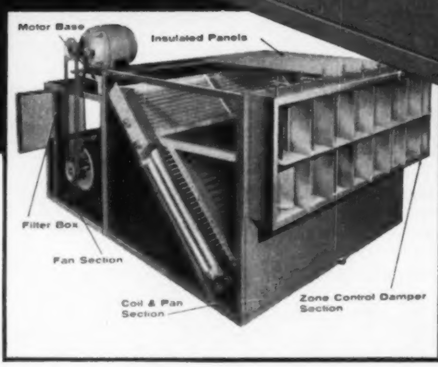
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN





ACCURATE TEMPERATURE CONTROL PROVIDED BY "BUFFALO" ZONE CONTROL CABINETS

"Buffalo" Zone Control Cabinets are engineered for installations where a single unit must provide varying degrees of conditioned air for several zones or rooms. These quiet operating compact units perform with peak economy, flexibility and dependability.

Temperature is controlled by mixing cooled and heated air in just the right proportions to suit each conditioned space. The need for separate re-heat coils and their controls is completely eliminated. Control for each area can be manual or entirely automatic.

"Buffalo" Zone Control Cabinets are sectionalized for maximum ease of installation. Removable panels and bearings located outside the cabinet simplify servicing. The entire unit is sturdily constructed to insure a long life of maintenance-free operation.

You're sure of satisfactory results when you specify "Buffalo" Zone Control Cabinets. Your "Buffalo" engineering representative will be pleased to provide you with information concerning unit selection, installation, etc. Contact him, or write us direct for Bulletin AC-220.

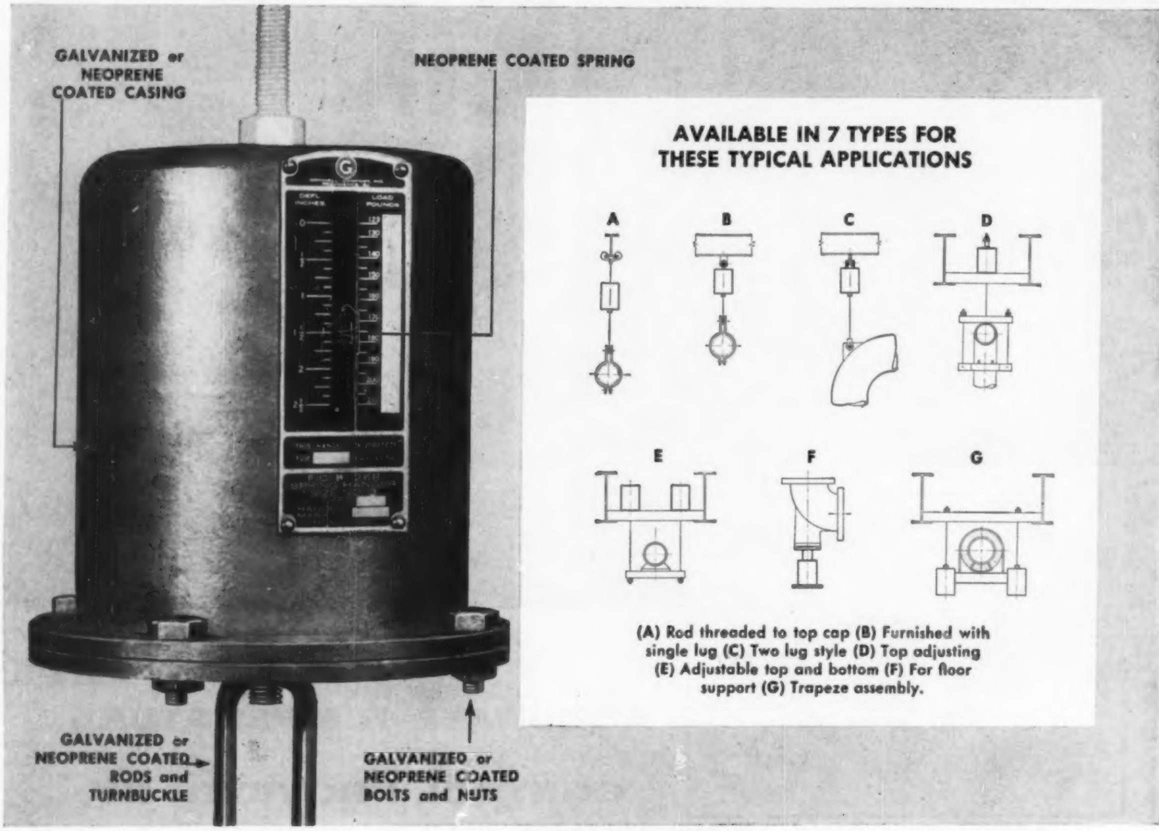
All "Buffalo" equipment brings you the "Q" Factor — the built-in QUALITY which provides trouble-free satisfaction and long life.

BUFFALO FORGE COMPANY
BUFFALO, NEW YORK
Buffalo Pumps Division • Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

corrosion-resistant, weather-resistant
GRINNELL VARIABLE SPRING HANGERS



In addition to their proven corrosion and weather resistance, these spring hangers offer other features.

- Maximum variation in supporting force for standard spring models per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression (a patented feature) assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.
- 21 sizes available from stock for load ranges from 50 lbs. to 28,200 lbs.
- Available in 3 spring lengths for maximum travel of 1¼, 2½, and 5 inches.
- Installation simplified by integral load scale and travel indicators.
- All-steel welded construction meets pressure piping code.

For hanger installations which are subject to highly corrosive industrial conditions — or where exposed to severe weather, Grinnell makes available two distinct lines of pre-engineered spring hangers.

These hangers are the result of extensive experimentation with various coatings for Grinnell's standard pre-engineered spring hangers. In addition to providing flexibility in pipe suspension, they provide versatility of application through their corrosion-resistant characteristics.

1. NEOPRENE COATED – for highly corrosive conditions, such as those found in chemical plants and refineries. All parts of the hanger are neoprene coated to protect the base metal from a wide range of corrosives. The flex life of the spring is unaffected by the neoprene . . . the coating resists cracking or flaking over a wide temperature range.

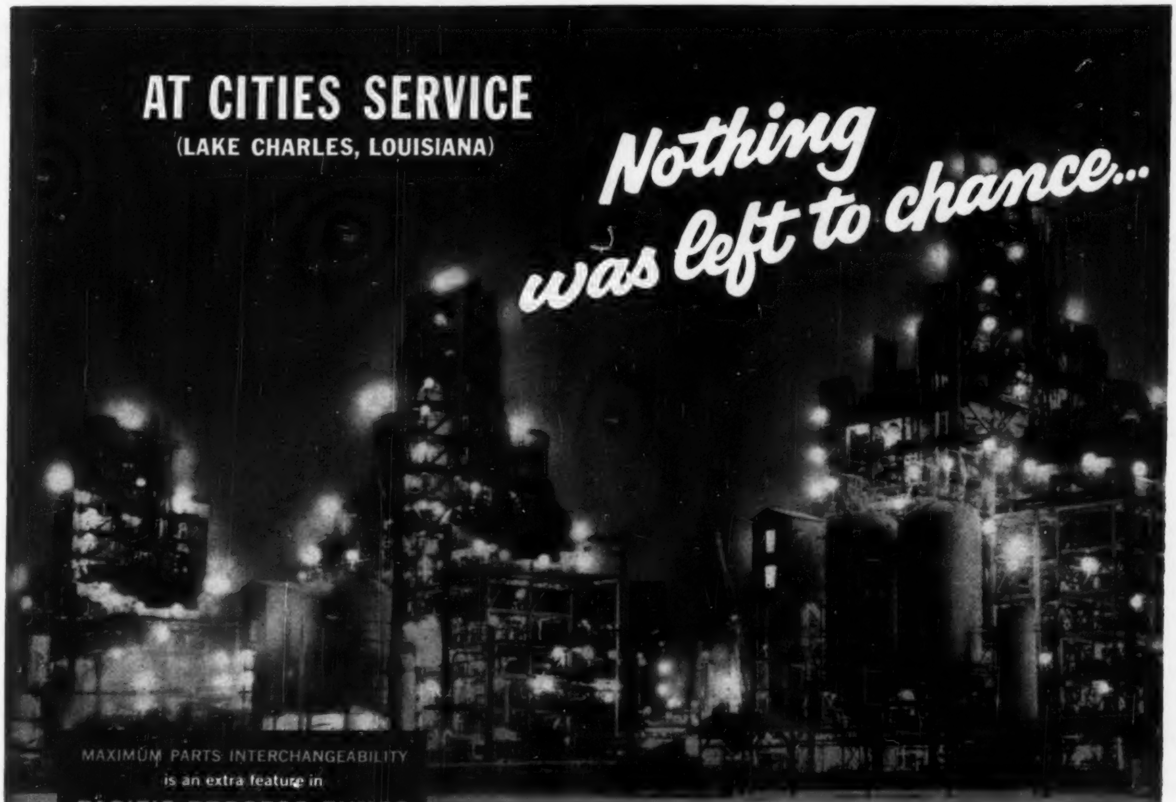
2. GALVANIZED – for outdoor installations, where weather conditions are severe. All parts of the hanger are galvanized except the spring, which is neoprene coated to avoid alterations of temper, hydrogen embrittlement and decreased flex-life of the spring – usual hazards to springs from the galvanizing process. Write for further details.

GRINNELL

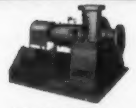
AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

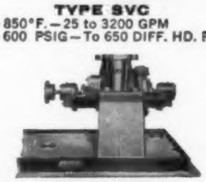
pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves • Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies • industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems



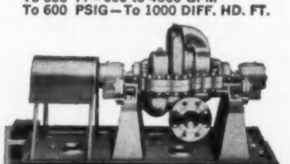
MAXIMUM PARTS INTERCHANGEABILITY
is an extra feature in
PACIFIC PROCESS PUMPS



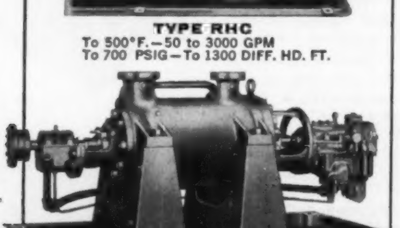
TYPE SVC
To 850°F.—25 to 3200 GPM
To 600 PSIG—To 650 DIFF. HD. FT.



TYPE HVC
To 850°F.—600 to 4500 GPM
To 600 PSIG—To 1000 DIFF. HD. FT.



TYPE RHC
To 500°F.—50 to 3000 GPM
To 700 PSIG—To 1300 DIFF. HD. FT.



TYPE AC
To 850°F.—100 to 2500 GPM
To 1000 PSIG—To 2600 DIFF. HD. FT.

Practically 100% PACIFIC

process pumps are in service at:

CITIES SERVICE REFINERY
PETRO-CHEMICAL, INC.
CIT-CON, INC.

The three fluid catalytic crackers illustrated have established new records for continuous operation since going on stream. Under the most demanding service conditions, all three units came through remarkably. Number two unit operated for 1058 consecutive 24-hour days only to be outdone by its sister unit with a record of 1065 days continuous operation. We feel that the 100% Pacific installation (including slurry pumps) contributed to making these run-records possible.

Elsewhere throughout Cities Service, P.C.I. and Cit-Con operations, Pacific process pumps are delivering equally dependable 'round-the-clock service... convincing evidence that "nothing was left to chance."

Write for Complete Line Bulletin 1C plus individual bulletins for pumps illustrated in panel.

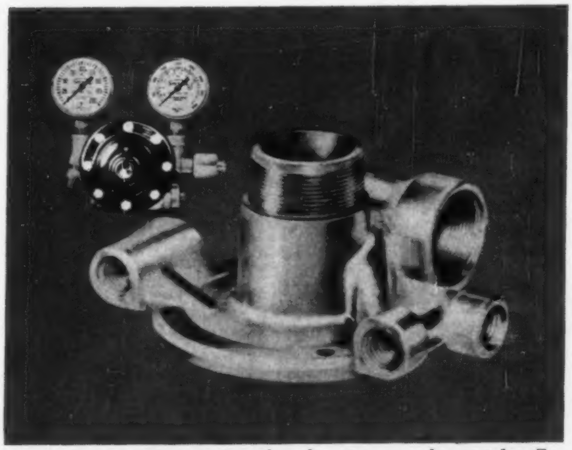
PACIFIC

PACIFIC PUMPS INC

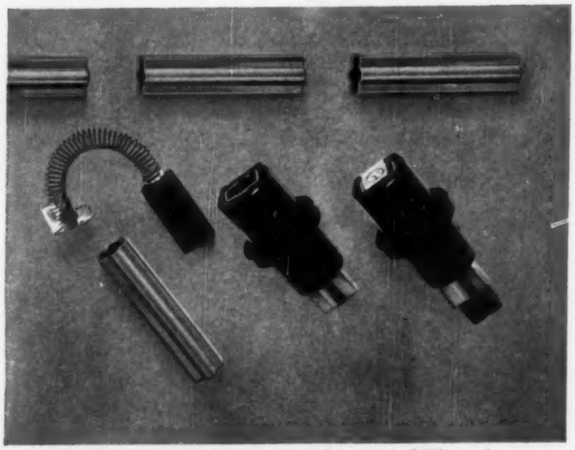
A Division of Dresser Industries, Inc.
HUNTINGTON PARK, CALIFORNIA

CP-20

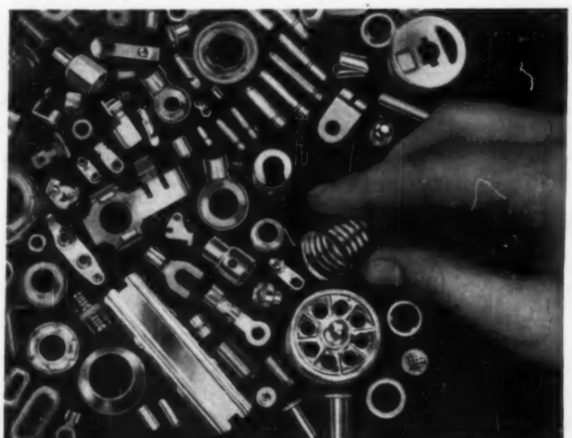
TAKE A FRESH LOOK at the way you are fabricating metal parts. Cost-cutting possibilities are almost unlimited with these Anaconda pre-formed mill products and press products.



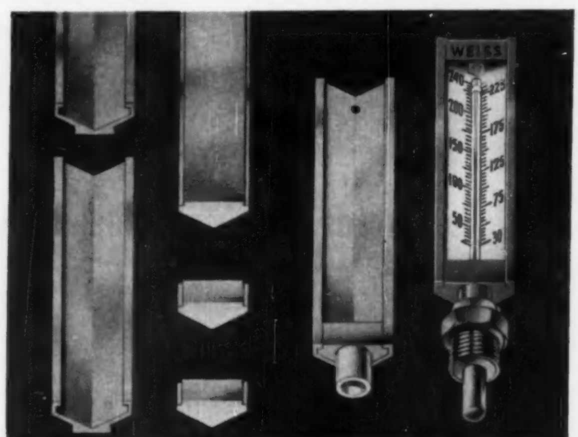
DIE-PRESSED FORGINGS, made of twice-wrought metal, offer superior uniformity, denseness, accuracy. *Savings:* replace more costly built-up assemblies—often are less in first cost than sand castings—require minimum surface machining to size—simplify secondary operations—lower tool cost—lower finishing cost.



SPECIAL-SHAPE TUBES can, as in the case of Electrolux, save several steps in arriving at a finished part. Brass electric-motor brush holder (above) is cut economically from long lengths of tube pre-shaped to accommodate both brush and spring. Uniform accuracy of all dimensions helps provide good brush stability.



MULTIPLE-PLUNGER AND PROGRESSIVE-TOOL-PRESS PRODUCTS are cutting costs throughout industry—often over 50%. Main reasons: The American Brass Company's complete design engineering service, long experience, specialized production equipment, a big selection of stock tools. Metals: copper, copper alloys, nickel, iron, steel, stainless steel, or aluminum.



EXTRUDED SHAPES. Wherever you fabricate from solid rod or bar—or castings—consider savings in machining, tooling and scrap by use of extruded shapes. Albert A. Weiss & Sons substituted two extruded shapes, above, for a sand casting—cut cost of thermometer case 41%, got an additional 30% saving in assembly because of consistently uniform dimensions.

HERE are four immediate approaches to cutting costs. Re-evaluate your designs and fabrication methods with these short cuts to finished products in mind. Wherever you spot a possible saving, send a sample, drawing, or description—with the quantity you need, the metal or properties you require—and ask for a quotation. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Limited, New Toronto, Ontario. 5853

DIE-PRESSED FORGINGS • SPECIAL-SHAPED TUBES
EXTRUSIONS • FABRICATED METAL GOODS

products of

ANACONDA®

Made by The American Brass Company

IN SRE... Zallea expansion joints absorb thermal expansion of reactor core tank and outer tank

The very nature of the Sodium Reactor Experiment, conducted by Atomics International for the AEC, and the method of handling the liquid sodium reactor coolant demand reliability in expansion joints. Because of the operation there can be no compromise in design or quality.

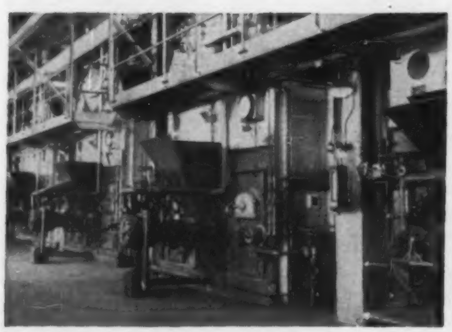
The high temperature SRE uses Zallea Expansion Joints where thermal expansion must be absorbed and where a gas seal must be maintained. An 11-ft. diameter Zallea Expansion Joint at the top of the outer tank absorbs the expansion that results from the temperature increase in these components as the reactor comes up to operating temperature, 960°F. In addition, the expansion joints form a seal for the helium gas and sodium vapor above the sodium pool at the top of the reactor as well as for the helium gas within the outer tank.

In the sodium coolant piping circuit gas seals are effected by means of Zallea Expansion Joints in the region where the pipes leave the reactor cavity and enter the pipe galleries.

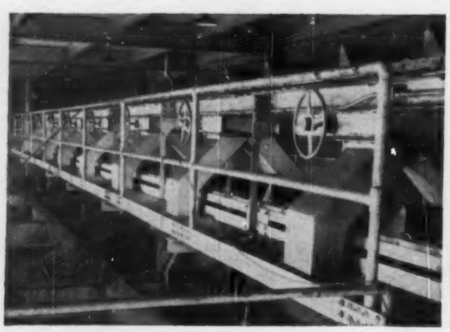
Zallea has worked with almost every major engineering and manufacturing firm engaged in atomic, nuclear and missile work—and has provided the large majority of expansion joints for such projects. As a result, we have accumulated a store of expansion joint engineering data and manufacturing skills that cannot be equalled. Whenever expansion is involved in piping systems, reactors, tanks—whatever the application—let our engineers work with you. We already have the answer to many of the difficulties you will encounter. And we welcome the chance of tackling your problem.

Zallea
expansion joints

ZALLEA BROTHERS, Wilmington 99, Del. • World's largest manufacturer of expansion joints

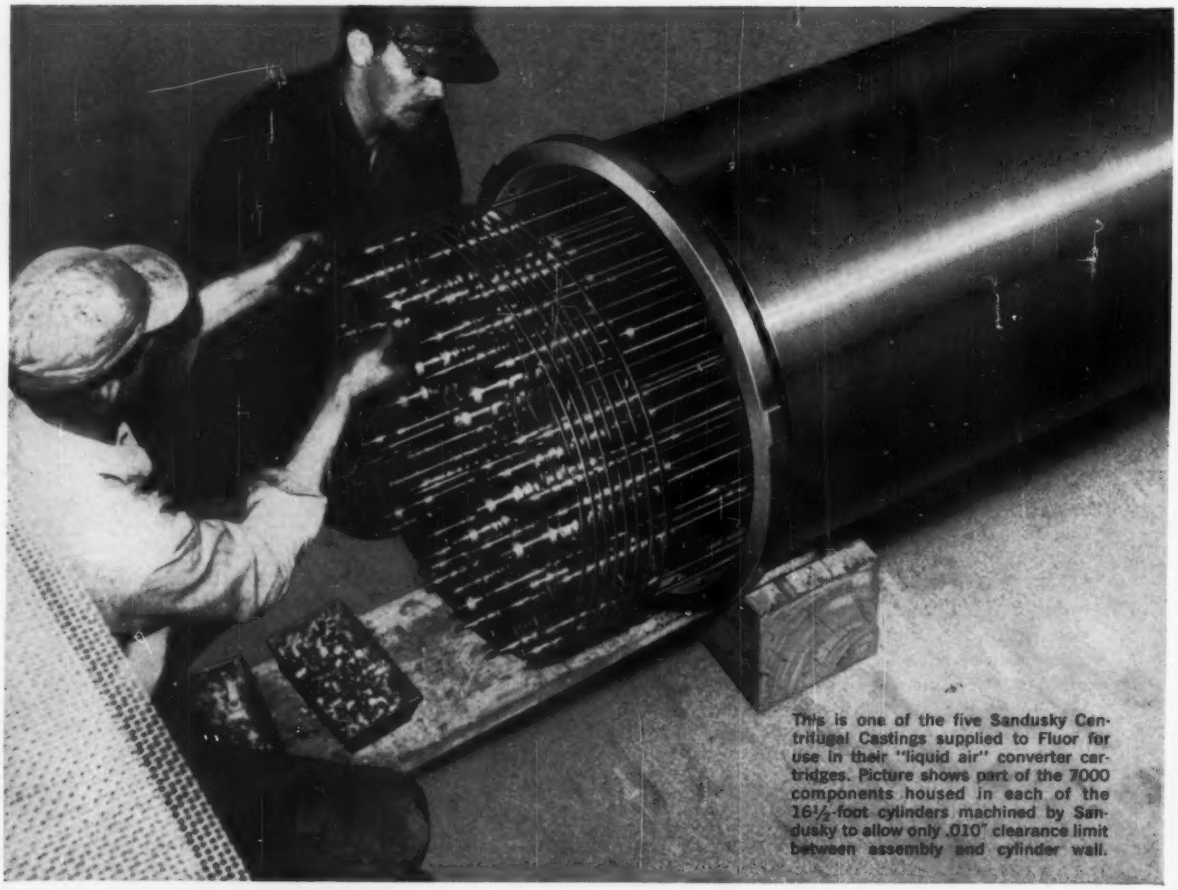


View of boiler room at State University. Boilers are 300 hp units, made by E. Keeler Co., and fired by Flynn and Emrich Single Retort Stokers. Average steam load currently is 9,000 lb/hr, requiring only one boiler most of the time.



The SY-CO Corp. V-bucket conveyor-elevator and 250-ton coal bunker storage area. Coal is delivered by truck to hopper, then moves by elevator to bunker. By the use of gates, coal may be channeled to any part of bunker.

This attractive power plant combines modern design with capacity sufficient to allow for expansion of campus facilities.



This is one of the five Sandusky Centrifugal Castings supplied to Fluor for use in their "liquid air" converter cartridges. Picture shows part of the 7000 components housed in each of the 16½-foot cylinders machined by Sandusky to allow only .010" clearance limit between assembly and cylinder wall.

SOLVED by Sandusky Centrifugal Castings:

This difficult precision-cost-delivery problem for the FLUOR PRODUCTS COMPANY.

Sandusky Quality Centrifugal Castings

Types: Rolls, Sleeves, Rings, Bearings, Bushings, Liners, Bands, Drums, Cylinders, Tubes, Shells, Retorts, Pressure Vessels, Pressure Piping

Sizes: From 7" to 54" O.D.—Lengths up to 33 feet

Materials: Stainless, Carbon and Low-Alloy Steels; full range of Copper-Base and Nickel-Base Alloys

Dimensional stability of Sandusky Centrifugal Castings enabled the Fluor Products Company to fit more than 7,000 precision parts into each of 5 identical cylinders supplied by Sandusky for use as ammonia synthesis converter cartridges.

Centrifugally cast of a modified CF8 (Type 304L) stainless steel, each cylinder was machined to finish dimensions 27¾" O.D., 26⅜" I.D., 199" long. The bore, surface finished to 35 micro inches, was held to .005" maximum out-of-roundness and .008" maximum taper.

What is more important, to meet Fluor's difficult assembly problems these large cylinders would have to be able to retain these carefully machined dimensions.

"The Fluor Products Company Engineers selected Sandusky Centrifugal Castings because of the stringent specifications, critical delivery requirements and competitive cost of this project. This was the first experience with such centrifugally cast products by the Fluor Products Company; and, the Sandusky Foundry and Machine Company people assisted in making this an extremely satisfactory and profitable project."

While you may have entirely different cylindrical design requirements, Sandusky Centrifugal Castings may well provide a similar cost-cutting answer. We would be pleased to have your inquiries.

SANDUSKY CENTRIFUGAL CASTINGS

FOUNDRY & MACHINE CO.

SANDUSKY, OHIO Stainless, Carbon, Low Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

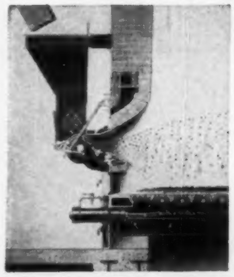
CHOOSE STOKER FIRING FOR ECONOMY AND SATISFACTION

Coal, Burned With a DETROIT STOKER Offers Many Advantages, Proven By Thousands of Installations

- Assured Fuel Supply
- Provides Steam At Lowest Cost
- Dependable—Noted For High Availability
- Maintenance Expense Low
- Requires Little Power For Operation

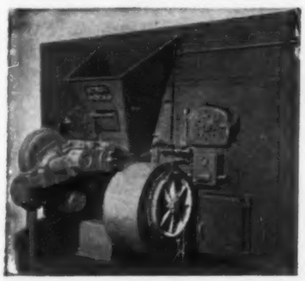
One of these Detroit Underfeed or Spreader Stokers will save you money—they are backed by over a half century of experience.

DETROIT ROTOSTOKER



Spreader stoker with OVERTHROW ROTORS that distribute the fuel uniformly in the furnace. Fine particles burned in suspension and coarse coal, burned on the grate. Four types of grates are available. RotoStokers burn successfully an extremely wide range of fuels without any special preparation. In combination with coal, RotoStokers also successfully burn wood and other refuse.

DETROIT UNISTOKER



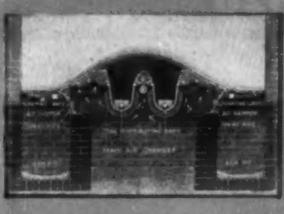
Plunger feed, side-cleaning stoker is available in various sizes for 125 to 250 horsepower boilers. Full-housed blower either motor or steam turbine driven, mounted at stoker front. Adjustable Feed provides for either manual or automatic coal feed control.

DETROIT ROTOSTOKER TYPE C-C

(Continuous Cleaning)

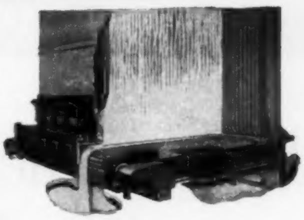
An important addition to the comprehensive "Detroit" line of spreader stokers. Readily applied to small and medium size steam generators approximately 5,000 to 75,000 pounds of steam per hour. The continuous cleaning grates automatically discharge the ash at the front for easy removal. No basement needed.

DETROIT DOUBLE RETORT STOKER



A multiple retort stoker having two retorts, with the side-cleaning feature requiring no basement. Now available with Detroit Adjustable Feed Coal Feed Control. For medium sized boilers.

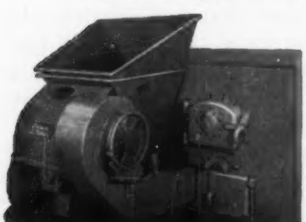
DETROIT ROTOGRATE STOKER



Spreader stoker with FORWARD MOVING GRATES for medium and large boilers up to approximately 400,000 pounds of steam per hour. Screenings or crushed run-of-mine coal used without grinding or pulverizing. Successfully burns a wide range of fuels, including lower grades of Bituminous Coal and Lignites . . . with preheated air if desired. Higher burning rates for longer periods with low excess air and without slagging or clinkering difficulties. Combustible in ash is unusually low.

DETROIT LOSTOKER

Has Detroit Adjustable Feed (Coal Feed Control).



A complete firing unit. Compact—single retort—mechanically driven—plunger feed—side-cleaning design. Many sizes and capacities for various types of boilers. Simple, accessible, dependable. A great coal saver.

DETROIT STOKER COMPANY

Main Office & Works, Monroe, Michigan

District Offices or Representatives in Principal Cities

7433

INVESTIGATE DETROIT STOKERS — IT'S THE ROAD TO ECONOMY AND SATISFACTION

MECHANICAL ENGINEERING

VOLUME 80 • NUMBER 11 • NOVEMBER, 1958

Progress in Power

Today's modern central station is a far cry from the pioneering Edison power plants of the 1880's. Tomorrow's generating stations will be still further advanced. This issue of MECHANICAL ENGINEERING is dedicated to this brilliant record of power-engineering progress. Through these pages, the authors not only look back to the days of the Corliss engine, with its 70-lb pressure at the throttle and its leisurely speed of 70 rpm, but consider the power station of the next 20 to 40 years—a 16 million-kw plant on a mile-square site. Fantastic? Perhaps! But experience tells us that the industry doubles every 10 years. Hence the largest U. S. steam-electric station, 1.5 million kw, if doubled every 10 years, would reach 16 million kw by 1990.

Such an accomplishment will, of course, require even more spectacular advances than we are witnessing today. The present 500-mw turbine size may well increase to 1000 mw. If a steam cycle is used, such a unit will require 6-million lb per hr of steam with a condenser of 400,000 to 500,000 sq ft, requiring 600,000 gpm, or 1350 cfs, of condensing water.

Further increases in steam temperatures and pressures, completely automated plants, combined steam and gas-turbine cycles, and the like, all will have an effect on changing the engineering scene in the power industry.

The impact of atomic energy is also having a profound effect on the power industry. More than 100 electric utilities in the United States are currently engaged in 22 separate nuclear-power projects which will result in the construction of 19 nuclear-power reactors. Combined capacity: More than 1.5 million kw at a cost to participating utilities of about $500 million. Largest nuclear station planned: Con Edison's 275,000-kw Indian Point plant now under construction near Peekskill, N. Y. However, of the 275,000 kw, about 112,000 kw will be supplied by an oil-fired superheater.

Nuclear power will, of course, be more expensive than conventional (13 mills per kwhr is estimated for Indian Point versus 8 mills per kwhr for conventional), but the operating experience gained from these plants, when completed, will not only serve to advance the art but point to future economical production of electrical power from the atom.

In still another vein, the gas turbine is finding its way into both industrial and central-station electric-power generation. World-wide gas-turbine central-station capacity totaled 1,546,000 hp in 1957.

The possibility of a nuclear gas-turbine power plant is also becoming attractive to engineers. So much so, that a substantial development program is already in progress.

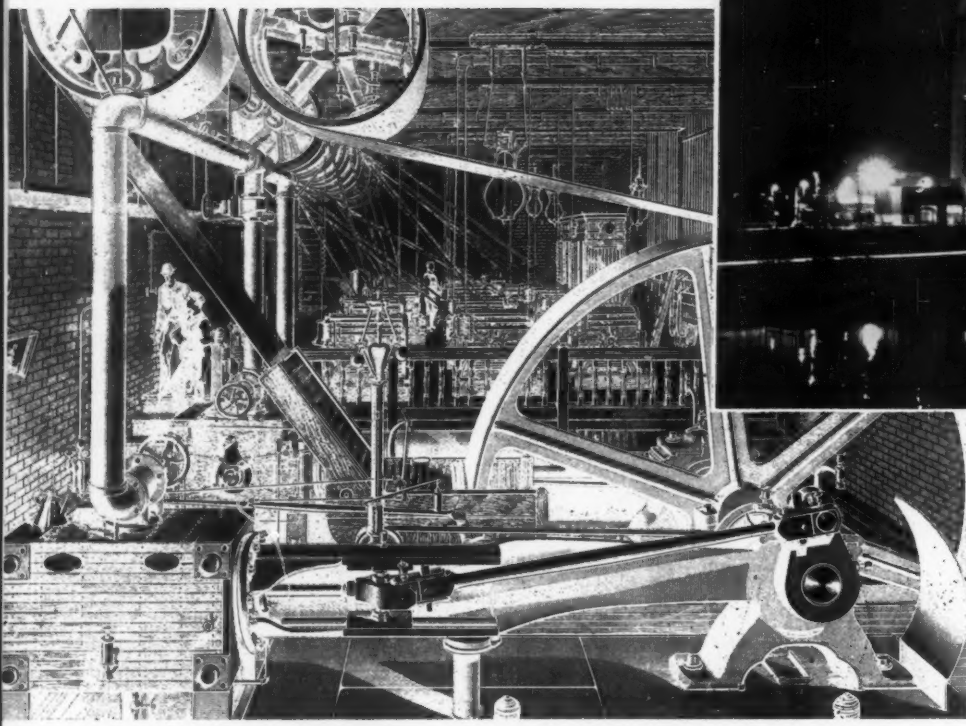
Looking even further ahead, in fact out of this world, a working model of an electric-power station for use on the moon has been demonstrated recently. This revolutionary generating unit would be powered by light from the sun. Thus the power industry is keeping alert to the space age that lies ahead.

Meanwhile, back on earth, all these spectacular and glamorous advances in the art and science of producing power will also require the best possible engineering talent. Thus the young engineer will do well to look toward an engineering career in the power field. Opportunities are unlimited. For in the last analysis, it is the engineer's contribution to central-station design that is responsible for the great progress in power.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

Editor Emeritus, GEORGE A. STETSON

TVA's Kingston plant—world's



Typical engine room in a central station of the 1880's

Patterns for

By Glenn R. Fryling, Mem. ASME,

Power plants may change unbelievably, but human beings are amazingly resistant to change. Upsetting

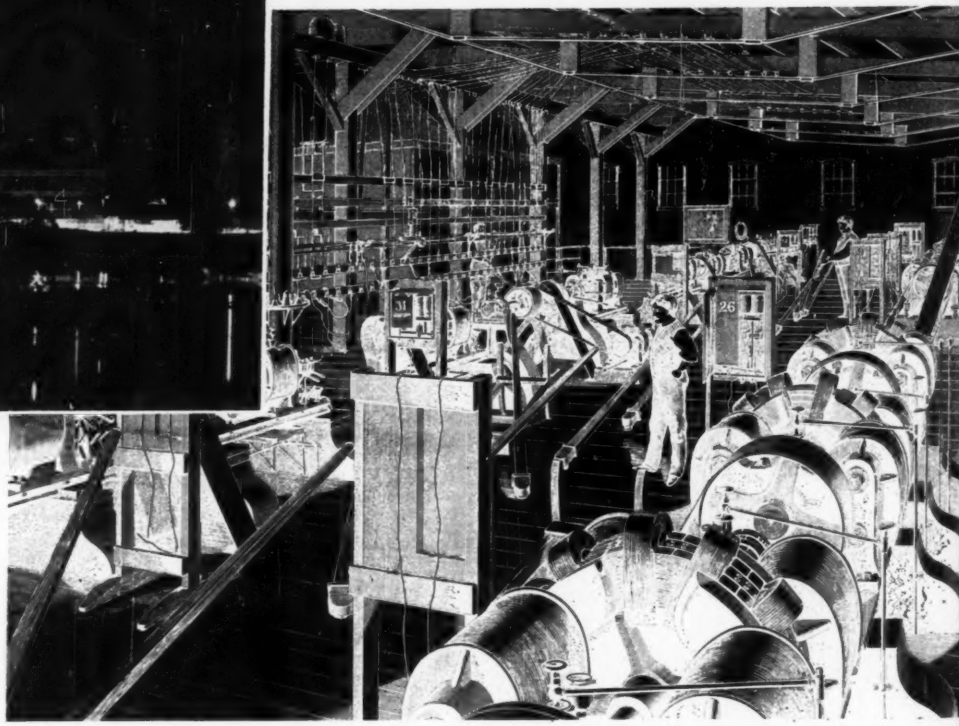
Visit a modern central station and what do you see? A massive structure, outdoor electrical transmission facilities, the glistening half-cylindrical casing of the turbine-generator, the boxed-in, skyscraper-shaped boiler, a brilliantly lighted control room that appears to be part office and part laboratory; and a complex array of piping and ductwork, pumps and fans, condensers, and fuel-burning equipment. You may also be impressed by the absence of people, for the modern central station can be categorized as the temple of automation. It is a kilowatt production facility that has a handful of maintenance men, a few technicians in the control room, and an office force to perform essential paper work.

Then picture yourself visiting one of the pioneer Edison central stations of the 1880's. In the perspective of those days, you would still have been impressed by the massiveness of the structure. But beyond that point you would likely be more concerned with differences than similarities. The three-wire direct-current system of the period required no transformers and very little external electrical apparatus for the limited service range of the station. Power generation by the combination of steam engine and dynamo was much more dynamic, personal, and visible. The counterpart of the modern turbine room was the machinery hall with its striking array of flywheels, governors, wide belts, and dynamos. Contrasted to the low and even noise level and the clean atmosphere of the modern turbine room were the occasional escape of steam, the rhythmic beat of engine valve gear, and the crackling sound of electricity arcing across faulty generator commutator bars. Men were everywhere in evidence, for the early central stations needed large numbers of oilers and electricians for manual operation. Boilers were small, generally hand-fired, and some plants had over 25 of them located on two or more levels. Control systems in the modern sense were unknown, and auxiliaries were few in number and simple in design.

Progress and People

What explains the remarkable progress in central station design over the past three quarters of a century? People—mainly engineers and industrial leaders—must be equated to such progress. The contrasts just painted are true ones, but they are the results of the efforts of countless individuals whose accomplishments rather than their names live after them. And yet woven through these advances are commonplace practices that everyone knows about but seldom recognizes as underlying progress. Such things as technical reports, conferences, and engineering society meetings constitute the modus operandi whereby engineers interact. In these personal relationships the innovator must overcome the understandable human preference for the status quo.

largest steam-electric station



Typical dynamo room in an early electric lighting station

Power Progress

Combustion Engineering, Inc., New York, N. Y.

established practice and accepted standards is oftentimes more difficult than duplicating proved designs.

The venturesome engineer must win over the embattled defenders of the safe and accepted ways of doing things.

Power plants may change unbelievably, but human beings are amazingly resistant to change. If you have any doubts, read on to find the rejoinder that an engineer of the 1880's made to a critic who wrote then, as has been written many times since, that new summits of technical achievement were insurmountable.

A group of business men in one of the large eastern cities was so impressed with the demonstration of Edison's then recently invented incandescent electric light that they banded together to form a local electric-generating company. Having arranged financing and a licensee agreement with an organization holding the Edison central-station patents, they hired a young engineering professor to serve as chief engineer of the new company. Like many young engineers, he was impatient with the past and eager to take bold steps for the future. Besides enthusiasm for the new job he brought with him an established reputation as a major contributor to a well-known engineering handbook and as author of an important text on steam-engine design.

In the 1880's Pearl Street was a symbol of the first and the best in central-station engineering practice. But the young chief engineer reasoned, why stop with "jumbo" dynamos and 100-psig boilers? Why not increase the size of the units, enlarge the station, and generate power more efficiently and economically?

These are familiar questions which recur practically every time a new central station is projected. While the answers provided from generation to generation may differ in accordance with the state of technical development, human reactions to proposals for advanced engineering practice follow much the same pattern.

Perils of an Innovator

Upsetting established practice and accepted standards is oftentimes more difficult than duplicating proved designs. There are many uncertainties in building a power station larger and more efficient than any in existence. So it was that the proposal of the chief engineer, to go to 150 psig and to install dynamos requiring 440-hp engines, met with the angry reactions of a pessimistic engineer from the patent-holding company who wrote a belligerent 14-page report from which the following comments are excerpted:

"In this report no effort is made to elaborate on details but simply to bring out clearly the most radical features of departure from our best and most reliable central-station practice.

"The constructors of this station have undertaken the application of a new type of dynamo of double the capacity of the largest dynamo the Parent Company have approved, and which it has taken this Company years to approach. . .

Patterns for

◀ Control room of a modern central station

"You will readily recall to mind the numerous meetings held previous to the commencement of construction on the New York stations, and that for some three years the question as to size of dynamos was very carefully considered at these meetings. . . . The questions of relative proportion between station capacity and requisite output in a district were very carefully considered, the result of all conferences being that it was deemed unwise to make the station units larger than 200 hp each.

"In accordance with this decision the original plans of the . . . station incorporated the use of No. 32 dynamos. These plans have been entirely changed, and the . . . Company have requested the Machine Works to build a dynamo to be known as type No. 56 . . . ; two of these dynamos to be driven by one engine will require at least 440 hp to operate them to their full capacity."

After discussing shortcomings of the electrical design of the plant, the author of the report reached the conclusion that the proposed plan was utterly impracticable and could not possibly be worked even if set up.

Turning to the steam side of the plant, the report writer had the following critical comments:

"In addition to the electrical features of this station which have been above noted, there are many features in the steam plant that may be considered as departing from what is generally accepted as the best steam practice in the United States, some of which may be briefly noted as follows:

"I am informed that it is intended to carry a working pressure of 150 pounds per square inch, which is from 40 to 50 pounds more pressure than is carried in any of the Edison central stations. The Pearl Street Station is operating with the highest steam pressure which averages 100 pounds per square inch. Under this high steam pressure extraordinary difficulties are encountered in keeping joints, packing, valves, and other places steam tight, in sound condition, and free from leaks and blowouts. While it is admitted that on locomotives and steam ships high pressures are used, careful investigation proves that there is not at the present date any important stationary steam plant in use in the United States that is successfully operating at a pressure approaching 150 pounds per square inch."

Rejoinder by Chief Engineer

The chief engineer to whom this report was addressed was far from discouraged and answered, "using plain words which are best in cases like this." He advised the president of the patent-holding company that he had carefully consulted with Thomas A. Edison and two of his principal associates and had received unqualified approval from them to purchase dynamos double the capacity of any previously installed. He added, "the wisdom of the change from a pecuniary point of view is undoubted."

Concluding his reply, the chief engineer stated:

"I trust that as the Station grows our ability to cope with the predicted difficulties will become greater. . . . I have not discussed the steam engineering because I do not think anything could be gained by it and you would not care for it. This part of the work has been carefully studied and elaborated in drawings and I shall be pleased to go over it in extenso with any competent authority you may suggest. I have endeavored to give this Company the best that there is in me and by untiring industry and vigilance to reach all the economy of running and speed of erection that is attainable. I shall be pleased to give any additional information that you may desire at any time."

How Power Progress Emerges

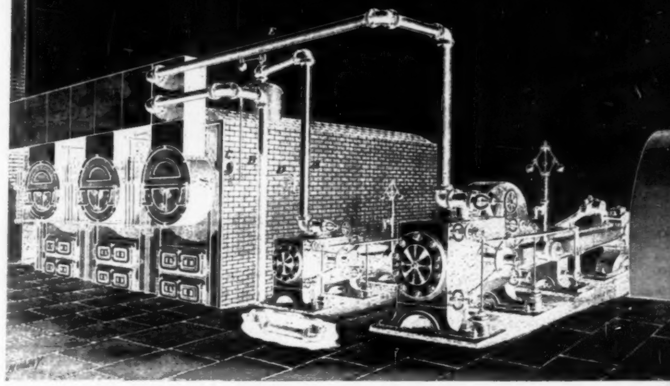
History proved the young chief engineer to be correct, for the station was built as planned and operated successfully. Power progress emerges from a battleground of protagonists such as these. This has been true since the days of Pearl Street Station three quarters of a century ago, and it will undoubtedly remain true in the days ahead when fossil fuels are eclipsed by power released from fission and fusion.

What are the driving forces that impel designers and builders of new power plants to achieve new highs in operating conditions, to go to unprecedented unit sizes, or to try promising but relatively untested new equipment designs? Ostensibly the new plant is intended to meet the requirements of forecasted power loads plus possibly replacing equivalent obsolete and uneconomic generating capacity.

In many cases prestige is a driving force. Throughout its history the central-station industry has been fortunate in having leaders who have had sufficient faith in engineering progress to risk large sums of money on promising but untried advances leading to more economic power generation. Likewise, manufacturers over the years have been eager to participate in improvements in power generation for reasons of prestige and long-term economic gain. By their very nature most new developments do not pay off on the first project. Yet once having been tried and proved in operating experience, a new technique or a new type of equipment is almost certain to be widely adopted. This justifies the risk on the part of both the manufacturer, who stands to benefit from additional equipment purchases, and the utility company, whose gain is measured in terms of reduced capital investment or decreased operating cost.

Prestige cannot be entirely separated from economics as a driving force toward more efficient power generation. A free-enterprise economic system makes "firsts" rewarding, and when load forecasts show justification for a boiler-turbine-generator unit larger than any heretofore built, then a forward-looking utility management is apt to purchase just such a unit. The utility company,

Power Progress



Reheat design of the 1880's ▶

its consulting engineers, and participating manufacturers all share in this economy and experience.

There are other catalysts of power progress. Free interchange of technical information is promoted by engineering societies, trade associations, and technical publications. In a very real sense there are no trade secrets among the electric utility companies. It is doubtful if any other industry is the beneficiary of more effective technical liaison than that existing among the utilities, their consulting engineers, and the equipment manufacturers. Many times each year these groups sit down and discuss mutual problems through such agencies as the prime-movers and power-generation committees of the Edison Electric Institute and the Association of Edison Illuminating Companies. In this way the principal manufacturers learn at first hand how their equipment is functioning and what difficulties, if any, have been encountered. At the same time the electric-utility industry is made aware of steps that may be taken to remedy operating problems and is given insight into future plans manufacturers may have.

The great battleground for many ideas that lead to power progress is the forum provided by the engineering societies. Such issues as turbine versus stationary steam engines occupied many ASME meetings around the turn of the century and took up hundreds of pages of its publications. Early in the history of the central-station industry electrical engineers argued the respective advantages and disadvantages of alternating and direct current at meetings of the AIEE. One of the major controversies of the post World War II era centered on the merits of the reheat cycle as a means of improving power-generation efficiency and counteracting rising fuel costs. Here again ASME provided an opportunity for discussion and publication of varying viewpoints.

Engineering societies have other roles contributing to power progress. Steam tables have reached their present state of development through research coordinated by ASME which is continuing its activity in this important field. The work of the ASME Boiler Code Committee is internationally recognized and its codes have been adopted by many city, state, and national-government agencies. As a result, boiler explosions are now an extreme rarity, and the Committee has contributed much to the effective and safe use of new materials under extreme conditions of temperature and pressure. Such groups as the Joint Boiler Feedwater Studies Committee and the Furnace Performance Factors Committee have conducted research and made outstanding contributions to power-plant literature. Not to be overlooked are the technical committees of the American Standards Association and the American Society for Testing Materials, much of whose work in standardization of materials, procedures, and techniques is an aid to more reliable and efficient power generation.

Education and Future Power Progress

This description of power progress would not be complete without asking, what of the future? We have seen that progress and people are inseparable. Engineering education is the means of instructing talented young people who will make future advances in power generation. Let us now look to the educational elements that will contribute to future progress.

Here we can learn from the past. Nearly a century ago—in 1859, to be exact—Prof. William John Macquorn Rankine published a monumental engineering textbook entitled "A Manual of the Steam Engine and Other Prime Movers." The engineering student who studied this text had to have a thorough grounding in mathematics through the calculus and differential equations. He had the opportunity of learning thermodynamics from the author of the first systematic treatise ever to appear on that subject. Those who mastered the text and graduated in the 1860's had knowledge of the mechanical and thermodynamic fundamentals of central-station design, including reheat and binary cycles, twenty years before Pearl Street.

It is this quality of imparting knowledge, useful many years beyond the first engineering position, that must be a keystone of curriculum planning by engineering educators. At a time of accelerated technological advancement, such as we are now experiencing, progress is dependent upon graduate engineers whose minds are not cluttered with details of rapidly outdated processes, techniques, or equipment. In recent years there has been a pronounced trend toward the inclusion of more subject matter dealing with basic engineering sciences. This is helpful in providing a sound theoretical background which can be filled in as the young engineer gains experience and grows in his chosen profession.

But theory is not enough to round out engineering education, for engineering is an art as well as a science, and engineers interact with other human beings as well as diagnose the ills of inanimate machines. Hence we must look to engineering educators to see that student engineers are taught a balance of both theory and practice. There is much evidence from recent experience in nuclear-power-plant design to show how wrong highly specialized theoreticians can be when elemental facts of power-plant operation and their relationships to power-system economy are overlooked.

As we have seen, engineers who have contributed to power progress have been able to communicate their ideas to others. In the future, as in the past, the means of reporting power progress will continue to be such prosaic activities as writing technical reports, participating in conferences, and delivering papers at engineering-society meetings. So it is that engineering educators must continue to insist that engineering students master both oral and written English. No matter what unforeseen developments come out of power progress of the future, they will still have to be expressed in words and recorded in type.

A LOOK AT THE FUTURE IN

It is by no means idle speculation to consider the power station of 20 to 40 years hence. The problems that may arise if present trends are followed must be considered in order to decide whether new approaches may be more rewarding. Stations being engineered today should still be usable to supplement the station of the future, perhaps by carrying the low-load-factor portion of the system load.

Possible Demand

First of all, how big will the industry be in 1977?

One of the first factors to be considered in estimating demand is the great potential of electric house heating. This was recently highlighted by R. G. MacDonald [1],[1] who stated, "At West Penn, an electric-heating saturation of 21 per cent would double the present sales of kwhr to homes and farms. Not only will electric heating be big business—70 billion kwhr by 1970—in itself, but it virtually assures getting 100 per cent of the cooking, water-heating, and clothes-drying load as well."

If repetition created facts, the number of times we have been assured that the industry would double every ten years would guarantee the forecast, and the present installed generating capability would expand to the almost fantastic figures:

	1957	1977	1997
	1×	4×	16×
Capability, million kw	135	540	2160
Generation, billion kwhr	632.6	2530	10000

The projected rate of utility growth is shown in two illustrations. The period up to the year 2000 is shown in Fig. 1, where trend lines are developed from actual plots of generating capacity. The setback caused by the depression is shown as a break in the trend. The Gompertz projection is extended to 2250 in Fig. 2. The figures show a possible 600-million-kw peak load by 1997 for generating 3600-billion kwhr, which may prove to be on the low side. A healthy growth of about 100-million-kw capacity in five years was about equal to that during the 50 years from 1902 to 1952 [2].

	Dec. 1957	1977	1997
Capability, million kw	135.45	365	735
Demand, million kw	110.85	305	615
Generation, billion kwhr	631.38	1760	3600
Load factor	65.0	66.0	67.0

[1] Numbers in brackets designate References at end of paper.

Contributed by the Power Division and presented at the Power Conference, Boston, Mass., September 28–October 1, 1958, of The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Condensed from Paper No. 58—Pwr-4.

With the present population of 170 million possibly becoming 231 million in 1975 and 340 million by 1997, spreading far afield from present city limits, there certainly will not be 16 times as many desirable plant and substation sites available.

The Sixteen-Million-kw Station

Although some may think it fantastic even to consider the future possibility of a 16-million-kw power station, a 3.6-million-kw hydroelectric station at Bratsk, USSR, may begin operation in 1960, while Krasnoyarsk will have 4 million kw. Applying the popular, but perhaps erroneous, concept of doubling every ten years, would bring the 16-million-kw station into being shortly after 1980. The largest U. S. steam-electric plant, 1.5 million kw, if doubled every 10 years, would reach 16 million kw around 1990.

Granting that a 4-million-kw station is at hand, just what problems are raised by a 16-million-kw station? Using the largest turbine-generator design of 500 mw presently available, there would be 32 units; allowing 150 ft width per unit, the plant would be 4800 ft long. Quite difficult to visualize! If turbine sizes increase to 1000 mw, there would be 16 units and a plant length of 2500 ft or more. Such a plant could well require a site of some 600 acres, or nearly a mile square.

Table 1 Water Requirements for Utility Steam Generation, 1954[a]

Kwhr generation by steam	360.8 billion
Millions of gal	
Total intake	23,895,631
Discharged to ground	23,828,059
Evaporated	67,573
Recirculation, equivalent intake	3,260,629
Gal per kwhr	
Total intake	66.2
Discharged to ground	66.0
Evaporated	0.2
Recirculated	8.8
Total use	75.0
Kind of water, million gal	
Fresh	18,469,283
Brackish	5,426,349
Total	23,895,631
Source of supply, million gal	
Public supply system	6,822,376
Self-operated system:	
Ground	17,055,215
Wells	18,040

[a] From the Federal Power Commission Report DC-57 which covered 99.6 per cent of total utility steam generation for the U. S., based on an estimated population of 162 million.

Will the 16-million-kw power plant on the mile-square site be the station of the future? Perhaps the solution to power-generation problems does not lie in doing better what we already know how to do, but in proving the technical and economic feasibility of new ways and means.

POWER-STATION DESIGN

By **E. H. Krieg**, Fellow ASME, Vice-President and Consulting Engineer, Stone & Webster Engineering Corporation, New York, N. Y.

The Mile-Square Site. Regardless of the size of units used, where could a 16-million-kw station be placed? At the time of construction, it may well be competing for area with 20-lane highways and with the attractive home sites along the coastline or rivers which are also ideal sites for large power plants. Many of the best of these have already been pre-empted.

Such a site would probably already be surrounded by home or industrial developments whose occupants would not be wholly inarticulate regarding the presence of 750 or 1000-kv transmission lines as neighbors. Some of our present million-kw plants require 400 or 500-ft-wide rights of way. What widths and voltages would be required for 16 million kw of transmission capacity? Will utilities become the largest landowners in each state? Certainly the present U. S. maximum voltage of 345 kv will be inadequate. Some present 230-kv users believe 460 kv is the next logical step, and many of us may live to see 1000 kv. Already a 4.5-mile, 40,000-kva, 600 to 750-kv experimental line is under development by General Electric Company, Western Massachusetts Electric Company, and Stone & Webster Engineering Corporation [3]. Operating experience on the 540-mile, 400-kv transmission line that delivers the output of 2100-mw Kuibyshev hydro plant to Moscow is said to have influenced the selection of 500 kv for the USSR grid. It is also reported that Russia has started construction of a 280-mile, 800-kv d-c line.

Circulating Water. How many sites could provide 10 to 11 million gpm of cooling water? Only the seacoasts, the Great Lakes, or the Mississippi, Ohio, or Columbia rivers, unless cooling towers are developed far beyond present experience. New large plants using cooling towers may have to obtain make-up by installing sewage-treatment plants, as was considered for a southern California plant several years ago.

The water requirements for 1954 utility steam generation in the U. S. are given in Table 1. If we continue to use 75 gal per kwhr, our water consumption 20 or 40 years hence will be in astronomical figures, and nuclear power plants using steam turbines require more circulating water per kwhr than modern steam-electric plants.

This matter of water demand, increasing both from a growing population as well as per-capita consumption, is a compounding problem. Domestic consumption will undoubtedly take precedence over industrial requirements so that in some areas, a supply for power generation from present sources may be little larger than is now available.

Fuel. Could a 16-million-kw station burn coal? With the most efficient present-day heat cycle, perhaps 11 million lb of coal an hour would be required, or a train of

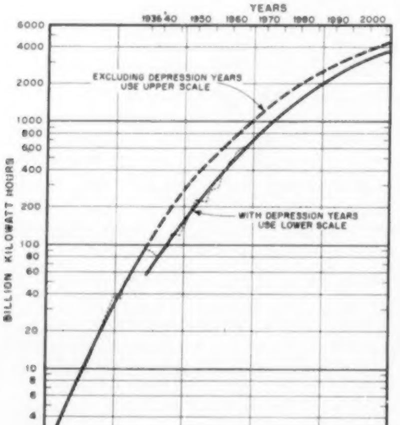


Fig. 1 The Gompertz curve extends the 1903 to 1956 utility growth to the year 2000

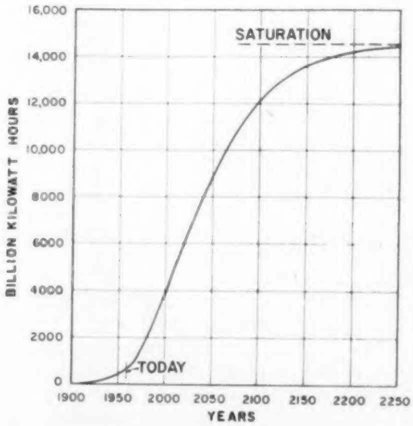


Fig. 2 The Gompertz curve redrawn to Cartesian ordinates

eighty 70-ton cars an hour, requiring two tracks solely for the needs of the station. The unbroken chain of railroad cars between the mine and the station, together with the coal-storage and handling facilities, may well require some other type of fuel delivery. Experiments with gasifying coal at the mine and transporting it by pipeline to the plant have produced such low Btu values per cu ft, that pipeline transportation of such gas appears remote.

Cost of Energy Transportation. Obtaining sites with sufficient water and economical fuel is only part of the problem in transporting potential energy from where it occurs as fuel or some other form, to where people live and industry thrives. Electricity is only one means of transporting energy and, as the problems and cost of transmission increase, the search will be intensified for more economical means to bridge the gap. Not only will rail and pipeline facilities compete with electrical transmission, but industry and population may find it more satisfactory to decentralize.

The development of a relatively small power plant that might transform some form of fission, solar, or potential thermal energy directly into electrical energy, requiring no cooling water and little or no transportation of fuel or ultimate product—electrical energy—may be the answer.

Trends in Minimizing Construction Costs

In the continuing effort to minimize the effect of ever-increasing equipment and construction costs beyond his control, the utility engineer has tried many trails: Bigness, area interconnections, standardization, improved availability, and many others.

Increase in Size of Turbines, Boilers, and Auxiliaries. The present trend of increasing size to reduce unit investment and operating costs will doubtless continue, and the present maximum turbine size of 500 mw may well increase to 1000 mw. Such a unit, if a steam cycle is still being used, may require around 6 million lb per hr of steam with a condenser of 400,000 to 500,000 sq ft, requiring 600,000 gpm, or 1350 cfs of condensing water. Obviously, there are few rivers having a minimum flow of 5400 cfs that would suffice for a 4-unit plant.

Such large turbines will automatically make much higher pressures feasible, and, even now, 3500-psi turbine-generators in sizes from 350 to 500 mw cost surprisingly less than the same sizes when designed for 2400 psi.

Already it has been realized, through sad failures of large forgings, that large machines require much better steel. Large forgings presently made from acid open-hearth steel will be made from basic electric-furnace steel poured in a vacuum. A few will become available by late 1958, and, by 1961, all large turbine-generator forgings are expected to be of the new type of steel. Steel companies will need to invest well over $30 million.

Boilers of 1-million-kw capacity will bring increased need for much higher heat-transfer rates, renewing interest in pressurized combustion with furnace pressures up to 100 psi in order to increase present heat-liberation rates of about 20,000 Btu per cu ft per hr. However, the high cost of "clean" fuel with high ash-fusion temperatures to avoid bad slagging and tube erosion will encourage the opposite trend to *decrease* heat-liberation rates. The high cost of coal cleaning or premium fuels, especially where transportation costs are not reduced by a higher Btu content per ton, would thus be avoided.

The high cost of piping compounded with problems of materials for high temperatures should bring the superheater outlet close to the turbine stop valves to minimize both main-steam and reheat piping. In a 1939–1940 design for a 75-mw, 2300-psi, 950-F unit, a short, straight pipe about 70 ft long permitted an installed cost of $10,223.47 to be attained for the steam lead. Perhaps boilers should be designed "upside ' wn" or "lying flat," or separately fired reheaters should be used.

Boiler feed pumps might be driven by 33,000-kw turbines as they already seem to be getting too large to be driven from the main shaft. Also, 3600 rpm may be too low a speed for economic pump design, and turbine drive is a simpler means of achieving higher speeds.

For locations having natural gas, there should be economy in driving large auxiliaries, such as the compressors used in pressurized boilers, with gas turbines that exhaust into the main furnace for heat recovery. Gas turbines may be installed in the gas ducts after the boiler to reduce flue-gas temperature, partially supplanting the work done by air heaters.

Interconnections. Many existing gaps between utility systems will be spanned by interconnections as transmission voltages and capacities increase. More systems will develop joint long-range plans for bulk-power supply, using larger units than the component systems could afford separately. Such planning, exemplified by Montaup Electric Company, is already in effect among several Connecticut utilities, the Pennsylvania-New Jersey-Maryland pool, and others. Considering the 1-million-kw, double-circuit, 345-kv interconnection between the American Electric Power and Commonwealth Edison Companies that went into service May, 1958, interconnections may become equal to the capacity of the largest unit, or 1 million kw per circuit.

Availability. Why should boilers be shut down for an annual inspection when a large unit has a loss in fixed charges alone of around $20,000 per day? Why shouldn't large boilers and turbines be operated 3 or 4 yr without an outage? Outages should be based, not on state laws that developed from experience with boilers now obsolete, but on current boiler experience.

Construction. If any underground plants are required for national security, nuclear-electric plants might well prove preferable. Much of a nuclear plant may well be underground for shielding, and the fossil fuel-handling and storage problems would disappear.

Attitudes affect investment costs as well as do pressures and temperatures. A cost-conscious and time-conscious organization can produce a substantial reduction in investment cost in an amount that is not greatly overshadowed by a 200 or 300-Btu gain in heat rate per kwhr that may be worth $500,000 or even more.

Energy Storage. Last, but not least, of the developments needed for reducing plant, transmission, and distribution investment would be some means of storing energy at each point of use. The battery yet to be developed for driving autos might be the answer. If the utility industry is anticipating homes with a 30-kw demand, one may naturally inquire: How many homes will be able to carry the $12,000 investment to the utility company?

Present Trends in Reducing Fuel Costs

The present expectation or trend of improving performance by continually increasing pressures and temperatures, assumes an extraordinary breakthrough in metal-

lurgy. Practically all of the metals presently used for high temperatures show a pronounced decrease in strength and other undesirable characteristics above 1100 F. Although a few very expensive metals may be used at perhaps 1500 F for gas turbines, there is little present expectation that they will become economically available for boilers and turbines as we know them today. There is little in sight to stir the imagination as to what metals might become available for steam temperatures up to or exceeding 1500 F for as much as 50,000 service hr, or approximately 6 service yr. Furthermore, with the decreasing rate of gain in performance at higher temperature steps, incentive to produce such metals is less.

Even the use of renewable high-temperature parts at perhaps 5-yr intervals does not seem to bring temperatures of over 1200 F into the economically feasible range, at least for the near future. Likewise, multiple stages of reheat do not appear to offer a sufficiently large financial incentive. This does not mean that an entirely different and more economical method of reheating may not be developed. Perhaps the reheater should be placed close to the turbine in a somewhat similar position as the large steam dryers being used with pressurized-water reactors. Some more economical method than is presently developed may be found to use a molten metal, or eutectic, or Dowtherm to bring heat from the gas passages of the boilers to the turbine, to minimize reheater pressure drop and very high reheater and piping costs.

There is little doubt that the larger units will require critical pressures, not only for thermal gain but to keep the size of turbine parts and piping down to reasonable dimensions and to eliminate boiler drums. Already, a 350-mw turbine-generator for 3500 psi costs several hundred thousand dollars less than one for 2400 psi and the same temperature. Pressures much above 3500 psi are difficult to justify today once the saving has been made in eliminating the boiler drum and achieving the lower turbine cost. The potential gains are appreciably offset by additional equipment costs, the risk to availability, and 52 per cent Federal Income Tax on incremental savings.

Although an initial temperature of 1050 F is fairly common today, difficulties with superheater and reheater austenitic tubing have taken away much of the economic incentive, but there is little doubt that the problem has been ameliorated, so that 1050 F should become increasingly common as fuel costs increase. How soon an initial or reheat temperature of 1100 F becomes economical will depend on possible advances in both austenitic and ferritic metallurgy.

Perhaps utility research should include work on metals, although it is questionable whether the high cost of such research is worth while.

Higher pressures and temperatures will be achieved, and in preparation the ASME Research Committee on Properties of Steam is presently co-operating in international research to extend the steam tables to 15,000 psi and 1500 F. From 10 to 20 years are needed for general adoption of extreme steam conditions because poor availability of the prototype units causes poor economy. Only an organization willing to live with the poor economy, large enough to absorb outages, and capable of correcting faulty conditions can justify such pioneering with the expectation of recovering the investment in the future with larger units.

Whereas cost and complexity have hitherto blocked earlier efforts to vary initial boiler pressure with load, thus eliminating turbine-control valves and operation on mid-valve points, large units and critical pressures should soon make this feasible. A substantial gain is possible, particularly on units that must serve a variable load.

The use of supercritical boiler pressures with attendant feedwater problems will require important developments, perhaps cooling and condensation of all vents, to reduce make-up and blowdown so that make-up will be added only during shutdown periods—say every four or five years. An important lesson has been learned from the hermetically sealed house-refrigerator unit that gives excellent availability by keeping human beings out.

More research is needed on boiler feed pumps before pressures much above critical become economic, as their present availability record is unattractive.

The 5000-Btu Steam Cycle and Other Cycles. When one considers how much time, energy, thought, research, and money are being spent to improve the steam cycle a few hundred Btu per kwhr, one wonders whether equivalent efforts are being made to achieve a larger proportion of the 5000-Btu-cycle plants that are possible through co-operation between utilities and industries. One of the earlier large examples is the Louisiana Station of Gulf States Utilities Company that began initial operation in 1930, with a present capacity of 4,000,000 lb per hr of process steam to nearby industry as well as a generating capability of about 221 mw of "by-product" electric power at far higher thermal efficiency than could be done with any supercritical cycle.

Fission, Fusion, and Solar Energy. Fission-fuel power will probably become more economical than power generated from fossil fuels because fossil-fuel costs are subject to increased mining and transportation costs through inflation, whereas fission-fuel costs evince some tendency to decrease. In addition, nuclear-electric plants will solve such fossil-fuel difficulties as air pollution, transportation, and storage. Furthermore, there is far more energy potential in uranium than in coal on the earth's surface. Although T. Fort of Westinghouse has predicted that 25 per cent of U. S.-installed electric-generating capacity will be in nuclear plants by 1978 with a growth of some 6 million kw per year, other predictions run from as low as 5 per cent to as high as 40 per cent. Even 5 per cent means a total of 20 million kw by 1975.

Perhaps new emphasis is needed on steam cycles suitable for nuclear power plants, such as some form of superheat and reheat to improve economy. Great dependence is being placed on obtaining satisfactory results from steam separators between turbine stages. If the expected performance is not attained, turbine-maintenance cost will increase and economy may be poorer.

Although the goal of electric power from controlled thermonuclear fusion may seem remote, it is of more than passing interest that a group of Texas electric-power systems are contributing a substantial sum to investigate.

Serious investigations of solar energy which holds promise for certain applications, such as building and water heating, are under way by the Association for Applied Solar Energy. While application for power generation appears more remote, let us not forget that solar energy is being used to operate the instruments on several satellites.

Energy Resources. To appreciate the relative position of our future energy resources exclusive of solar energy, AEC and other U. S. sources have stated the following: (*a*) Present U. S. annual consumption of energy is 0.01 Q where $Q = 10^{18}$ Btu; (*b*) oil resources = 0.4 Q or 40 yr; (*c*) coal resources = 6.8 Q with an estimated 6 Q or 600

yr economically available, using present mining methods; (*d*) uranium = 12 *Q* or 1200-yr supply which may increase to 100 *Q* with "breeding."

In 1951, 25 per cent of total U. S. power generation of the total 400-billion-kwhr power generation was hydro, with the fuel consumption for 300 billion kwhr amounting to about 0.003 *Q*.

B. C. Netschert in a recent study of U. S. energy sources concluded, "that in 1975, or thereabouts, domestic availability, at no appreciable increase in constant dollar costs, could be about 6 billion barrels of crude oil and 22.5 trillion cu ft of natural gas per year." U. S. production in 1957 was around 2.7 billion barrels of crude oil, and 12 trillion cu ft of natural gas [4]. He also estimates a possible 500 billion barrels of oil and 1.2 quadrillion cu ft of natural gas for exploitation. This amount will not necessarily be discovered or extracted.

While it is fortunate that there seems to be no immediate shortage of fossil fuels which would cause immediate demand for nuclear power in this country, there is still ample incentive for nuclear power generation caused by the economic pressure of a 3 per cent increase in coal and transportation costs per year.

Performance Control. Equipment to analyze the operation of the very large steam-generating units of the future is already available, using sensing elements linked to analog scanners that probe hundreds of different boiler locations to collect such data as temperature, pressure, and gas composition [5, 6]. An electronic computer could control much of the station, record only load and heat rate, and transmit the records to a central point. Computer-controllers could also regulate the economic loading of units and stations, which would improve the economics of interconnection.

Maintenance. Corrosion is one of the really major maintenance problems, and it is trite to mention that new types of protection are needed for steel work in contact with gases near the dewpoint, steel-sheet piling around intakes and wharves, for circulating-water screens, and much of the service-water and chemical piping. Stainless steel is too expensive, and plastic pipe has temperature and size limitations. Iron pickup by feedwater has become a problem which would be ameliorated by coatings for the inside of condenser and bleed-heater shells, as well as condensate and feedwater piping. Paints that will cover a wider spectrum of temperature conditions will no doubt be developed.

A Critique of Present Trends

If we try to make the future steam-electric plant an extrapolation of present trends, do not the problems to be solved require greater effort than finding a new approach? In economizing on power-generation and transmission costs, the major effort has been along the lines of:

1 Bigness—but are 1-million-kw units in plants of 4 to 16-million kw capacity the answer?

2 Higher pressures and temperatures—but isn't it questionable whether supercritical plants with superheat and reheat temperatures of over 1100 F are feasible unless we have a near-miracle breakthrough in metallurgy?

3 More reheat—but will this not require premium fuels (even if metals become available) so that high furnace-exit gas temperatures will not slag superheaters and reheaters, if not furnace walls as well?

In contrast to the foregoing major developments, have we really given the 5000-Btu cycle a real tryout? There are relatively few instances where large industries receive steam and electricity wholly from utility-owned plants.

Perhaps our utility-engineering philosophy needs a review in the broadest sense, with a realization that the solutions to power-generation problems do not lie necessarily in doing better what we already know how to do, but in proving the technical and economic feasibility of new ways and means of meeting future requirements [7].

Although presently known methods of direct production of electricity pose no trace of threat to the use of turbine-generators, nevertheless many scientists are laboring along such trails as: (*a*) Thermal-electric generation (similar to a thermocouple) employing semiconductor materials, which could equally well provide thermal-electric cooling; (*b*) thermomagnetic generation producing low-frequency a-c current; (*c*) phase-transition potentials, such as between ice and sea water or electricity in thunderstorms; (*d*) pyroelectric generation when certain crystals are heated, as tartaric acid; (*e*) thermionic converters in which electrons are "boiled out" of a hot metal surface to produce electric current directly. V. C. Wilson of General Electric believes an efficiency of 30 per cent may be theoretically possible; (*f*) Kaye and Hatsopoulos of M.I.T. have produced electricity using two plates heated at different temperatures within a vacuum, and are investigating another thermoelectric engine which uses crossed electric and magnetic fields; (*g*) the National Carbon Company Division of Union Carbide Company has developed a fuel cell which produces electricity directly from the chemical energy of hydrogen and oxygen with 65 to 80 per cent efficiency.

Until the past few years, the gains in fuel economy together with the reduction in investment requirements that were achieved by intelligent engineering have more than compensated for the sharp increase in construction-cost indexes, fuel costs, and labor costs. In the future, inflation of material and labor costs will probably increase faster than technological improvements, causing power costs to apparently increase. This challenge must be clearly recognized to insure a sound development of the industry and to attain an optimum combination of technical soundness and economic responsibility.

Although some of our pressing needs are delineated in this paper, the real objective is to bring into focus a few of the host of problems that are, or will be, pressing for solution. Until the problem has been visualized, as stated, we cannot work on it.

Acknowledgment

The stimulation of many present and retired colleagues, especially Dr. W. F. Ryan and S. G. Coffin, and their assistance in editing, are gratefully acknowledged.

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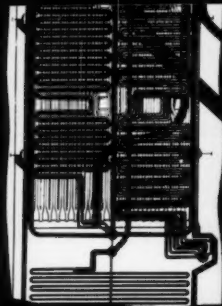
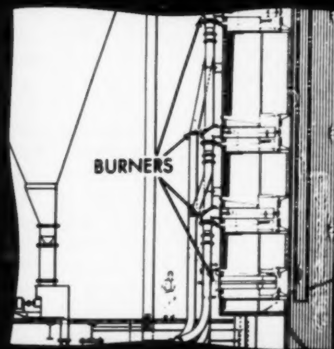
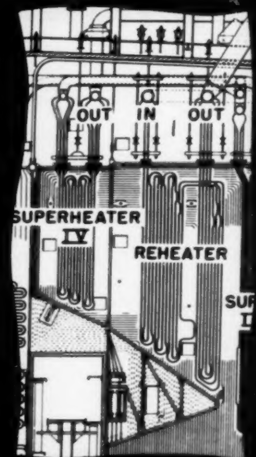
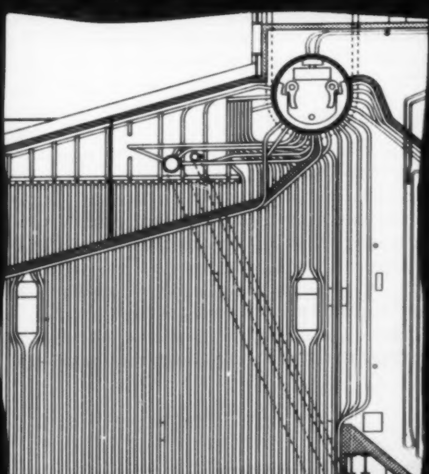


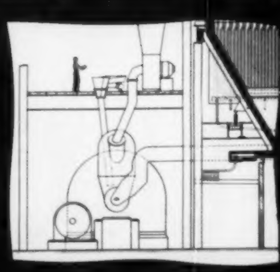
In less than five years boilers are expected to generate 3,500,000 lb of steam per hr to supply a 500,000-kw unit operating at 3500 psi and 1050 F. New materials, controlled circulation, combined cycles, multiple fuels, and preheating all play a part in the drive for more economical units.





Steam Generator design trends





Based on the following papers contributed by the Power Division and presented at the National Power Conference, Boston, Mass., Sept. 28-Oct. 1, 1958, of The ASME and AIEE:

1 **A PREVIEW OF TOMORROW'S BOILERS**
E. M. Powell and J. I. Argersinger, Combustion Engineering

2 **MODERN STEAM GENERATOR DESIGNS**
D. R. Wilson, Babcock & Wilcox

3 **TRENDS IN PRESENT-DAY BOILER DESIGN**
Donald B. Stewart, Foster Wheeler

4 **DESIGN REQUIREMENTS FOR STEAM GENERATION WITH HIGH-COST FUELS**
C. F. Hawley, Riley Stoker

A Preview of Tomorrow's Boilers

By E. M. Powell, Mem. ASME, and
J. I. Argersinger, Assoc. Mem. ASME
Combustion Engineering, Inc., New York, N. Y.

An extrapolation of successful operating experience would indicate that the boiler of tomorrow will generate 3,500,000 lb of steam per hr to supply a 500,000-kw unit operating at 3500 psi and 1050 F with double reheat at 1050 F. Economics demands the use of such high-capacity units to meet the doubling of the electric power load which has taken place every eight or ten years. It was predicted in 1956 that a unit size of 500 mw would be achieved by 1960. Actually, this has occurred two years ahead of schedule. The Tennessee Valley Authority now has on order a boiler of 3,700,000-lb-per-hr capacity to serve a 500-mw turbine generator.

Likewise, economics demands equipment of increased efficiency and plant cycles with lower heat rates to offset the rising price of fuel. In general, this means the use of higher steam pressures and temperatures.

Sub and Supercritical Pressures

Operating pressures have increased from about 200 psi at the beginning of the century to above 2000 psi in 1957, with the standard or generally accepted maximum at 2400 psi at the turbine throttle. We are face to face with the critical pressure, and the next logical step, the proper engineering step, is to go above it.

What is critical pressure? What does it mean to generate steam above critical pressure? In an enthalpy diagram, the saturated-water line and saturated-steam line meet at the critical point of approximately 3206 psi and 705 F.

In a boiler, heat is added at essentially constant pressure, and the temperature rises until the saturation temperature for the existing pressure is reached. As further heat is added, there is no change in temperature, but the water boils and steam bubbles are formed. The volume of the mixture of steam and water increases rapidly, especially at the lower pressures, until the water has been evaporated, and dry steam—still at saturation temperature—remains. Further addition of heat brings us into the superheat region, with the temperature and volume increasing in a manner that approaches the perfect gas laws.

At some pressure above critical, say 4000 psi, water, which is practically incompressible, will have almost the same specific volume as water of the same temperature at any other pressure. It will also have about the same heat content. As we add heat, the temperature rises, about 1 deg for each Btu per lb of water, just as it does below critical pressure, and the volume increases very little. As the temperature gets above 700 F, the rate of increase in temperature becomes slower, but the rate of increase in specific volume becomes more rapid. We are getting into the transition zone. There is no boiling, or separation of steam bubbles. There is no zone in which the temperature remains constant while we add latent heat. There is no condition which we can identify as marking the boundary between the liquid and vapor phases. However, by the time we get somewhat over 800 F, the characteristics of the fluid are completely analogous to superheated steam below critical pressure. Certainly for all engineering purposes it can be considered steam.

A little consideration of this process of forming steam above critical pressure leads quickly to the conclusion that conventional boilers are not suitable. A boiler of the once-through type is required.

Boiler Circulation Types

The basic differences between types of circulation in boilers are simply illustrated in Fig. 1. In a natural-circulation boiler, lower left, feedwater is pumped through the economizer into the boiler drum. It passes through downtake pipes or tubes into the bottom of the heated evaporating surface. This is usually the water wall in modern designs. The addition of heat causes boiling, and the decreased density of the boiling mixture creates circulation. The mixture of steam and water returns to the drum. Steam is separated from

Condensed from ASME Paper No. 58—Pwr-14.

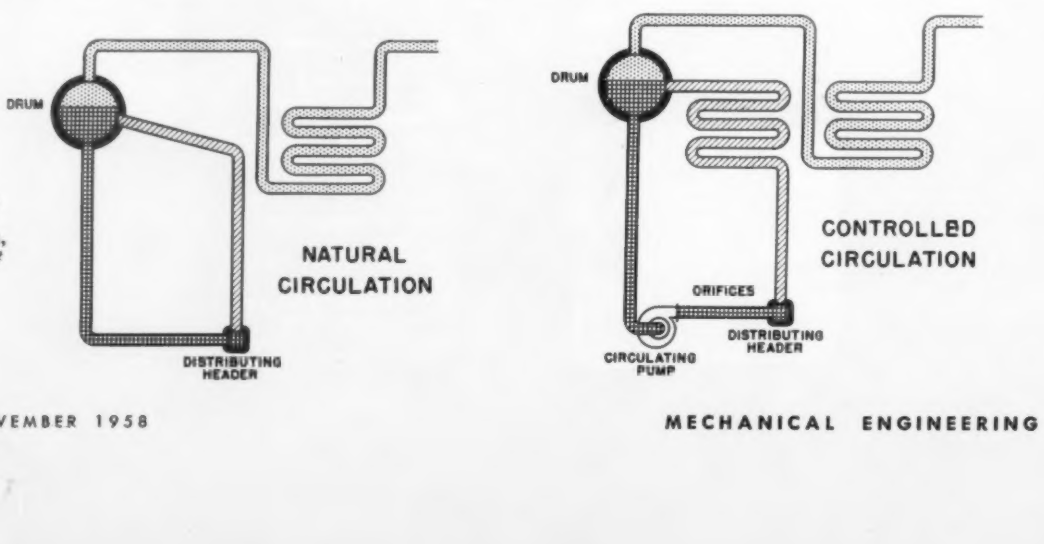


Fig. 1 Principles of boiler circulation, shown *left to right*

the water and is forced through the superheater to the outlet of the unit.

We might call this yesterday's boiler, although this does not imply that it has outlived its usefulness for many utility and industrial plants at moderate pressure levels.

Since the circulation depends on the difference in density between steam and water, the rising trend in operating pressure gave the designer an increasingly difficult problem. An answer is provided by the controlled-circulation design, shown at the upper right, which has been widely applied during the past 10 years in the pressure range above 2000 psi but below critical pressure. Pumps are provided to produce positive circulation, independent of heat absorption or relative density of steam and water mixture. Orifices are used to distribute water to parallel circuits of varying resistance in proportion to their requirements.

Over 100 units of this type have been ordered up to the end of 1957 with a total capacity of almost 130,000,000 lb per hr representing over 23 per cent of the industry purchase in sizes over 50,000 kw.

Monotube Boiler—Subcritical Pressure

The monotube boiler is a once-through boiler which can be applied either above or below the critical pressure. The author's company now has six steam-generating units of the monotube design in various stages of construction or in operation, representing a combined capability of nearly 1,500,000 kw. In the design for subcritical pressure, shown at lower left, there is no recirculation of water within the unit. The fluid passes in sequence through the economizer, the evaporating portion, and the various sections of the superheater.

In a large-capacity unit, tubes in parallel are necessary to handle the flow of water and steam. The stable distribution of flow between these parallel circuits is assured by several features of the monotube-boiler design. This factor of stability is most critical in the evaporating section where a mixture of two phases must be maintained. The continuity of tubes throughout the evaporating section eliminates the problem of handling a mixture of water and steam in a header and distributing both phases uniformly into a large number of tubes. It is this feature of continuous tubes which gives rise to the name "monotube."

A second design feature is that all the tubes pass several times in parallel through all parts of the furnace, so that each receives the same total amount of heat, thus minimizing the effect of any local disturbance, such as burner adjustment or soot-blower operation.

An orifice is located at the inlet of each water-wall tube to provide a fixed resistance, to improve stability, and to control distribution in the same manner as in a controlled-circulation unit. Finally, an adjustable resistance in the form of a seatless valve is included at the inlet to each small group of tubes, permitting adjustment for unavoidable minor differences due to design or fabrication.

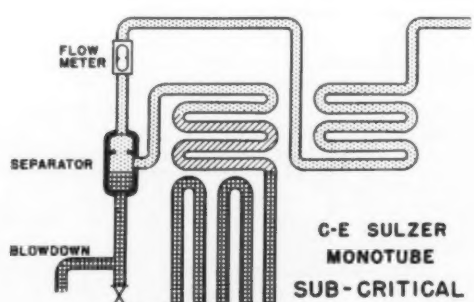
Another feature of the monotube design for subcritical pressure is the boiler-water separator. The feedwater is controlled to maintain a small amount of moisture in the steam at the water-wall outlet. The moisture is removed in the separator, carrying with it, in concentrated form, a large portion of any impurities in the feedwater. The discharge from the water separator can be piped partially to continuous blowdown, and the remainder returned to the cycle in the high-pressure feedwater heaters. High purity of feedwater is a requirement of all once-through boilers, especially if long-time continuous operation is to be achieved. With a water separator the requirements are slightly less critical, because chemical blowdown can be utilized. Also the evaporative circuits can be washed or flushed during operation, by temporarily increasing the feedwater flow slightly above normal requirements.

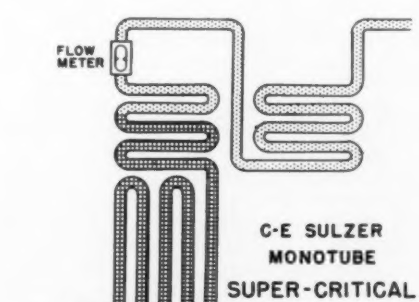
The water separator also maintains the steam at the superheater inlet at a constant condition, dry and saturated, making regulation of the outlet temperature more accurate and uniform.

Finally, the water separator makes it possible to restart the boiler quickly when hot, without quenching the hot superheater metal, and with a minimum change in superheater-outlet temperature. The firing rate required is less, and more uniform temperatures are produced throughout the steam-generating unit, lessening expansion problems.

The monotube boiler, at subcritical pressure, is well adapted to the use of radiant-superheater surface, with the superheater protected by positive flow during all conditions. The use of high steam temperatures and reheat temperatures make radiant superheaters more attractive. The monotube design eliminates the large boiler drum and minimizes the quantity of water-wall headers and connecting piping, particularly as compared with natural-circulation units.

The monotube boiler is extremely flexible in operation. It is ideally suited to quick starting, and it can be operated over a wide load range. By taking





advantage of the water separator, the steam output can be reduced to 10 per cent or even lower, while still maintaining adequate flow in the furnace tubes.

Monotube Boiler—Supercritical Pressure

The monotube design for supercritical pressure is even simpler than the design for subcritical pressure. Since there is no separation of the two phases above 3206 psi, and the increase in specific volume is much less than in the lower pressure range, stability of flow distribution is much easier to maintain. The general arrangement of the tubes is based on the same fundamentals.

The boiler-water separator is omitted, since it cannot function above critical pressure. Continuous blowdown is no longer available and any impurities in the feedwater are either deposited in the boiler or carried over in the steam to the turbine. The need for water of the highest commercially available standard under all conditions of operation is of utmost importance. This can be satisfied with tight condensers, demineralized make-up, and the best possible system for generation, with provision for filtration and demineralization of some portion of the condensate.

In utility-plant development and cycle improvement, rising pressure has gone hand in hand with rising temperature. The limitation of temperature lies in the materials available and their cost and life expectancy, a problem which is now receiving especially concentrated study. The benefit of high temperature may be obtained by increasing the throttle temperature and also by use of either single or multiple-reheat cycle.

Although prediction is difficult, it is likely that 1050 F superheater-outlet steam temperature and double reheat, 1050 F from both stages, will be used for a good commercial design of tomorrow's boiler.

Boiler Controls

The rising cost of labor in the power industry, as in every industry, is one of the factors that encourages the use of high-capacity units and the maximum amount of automatic control. Likewise the trend to high pressure and high temperature calls for the fullest use of automatic control. High-pressure boilers inherently have less storage capacity and are more responsive to changing conditions. High temperature, on the other hand, demands that variations be kept at a minimum to prolong the life of the equipment. The system used for monotube boilers controls feedwater flow, steam temperature, and the essential turbine bypass, providing many of the control features required for safe, efficient, automatic co-ordination of the boiler and turbine.

The basic concept of the boiler-turbine control system is shown schematically in Fig. 2, including the turbine-generator set on the right, and the steam-generating unit on the left. The desired end product of the unit is, of course, electrical energy. It is logical then that the generator output be used to regulate the combustion-control system and determine the quantity of fuel and air which is to be supplied to the boiler unit where the energy can be converted and delivered to the turbine in superheated steam. It is the function of the turbine and feedwater-control system to insure that the steam is admitted to the turbine at the proper temperature and pressure to suit the design conditions of the equipment.

Provision has been made, however, in the turbine and combustion controls to transfer to a more conventional control from the direct-acting system illustrated, which is based on European practice and is an innovation to operators in this country.

Variable Pressure

Variable or sliding pressure has been the subject of much discussion with the advent of the once-through boiler in the power-generation field and is considered desirable where there is a potential savings if the throttle pressure can be reduced with load. Because of the corresponding reduction of stored energy in the boiler, it is obviously desirable to modify such a system for an adjustable pressure which will retain some of the reserve energy characteristic of constant-pressure operation for quick pickup, while at the same time realizing some of the gain in cycle efficiency incident to reduced-pressure operation at lower loads.

On the other hand, with lower pressure cycles where it is possible to operate one or more turbine valves sequentially, the gain in cycle efficiency with variable-pressure operation all but disappears. In such instances the inherent disadvantages could well offset the advantages.

Controlled Circulation

Based on the requirements outlined, what will tomorrow's boiler look like? Possibly it would be unwise to confine our thoughts to only one, and better to take a look at three typical designs. Certainly controlled circulation has established such an enviable record of performance that it will undoubtedly play a most important part in providing the additional capacity to be installed in the years immediately ahead.

The principal factors which have led to such wide acceptance of controlled circulation are fundamentally related to the limitations of natural circulation in the elevated subcritical-pressure ranges above 2000 psi at the turbine throttle, and particularly as these exist in very large units.

Boiler structures are now becoming of such large physical size, at 200,000 to 600,000 kw, that controlled circulation (or once-through circulation) can be of considerable advantage in establishing positive flow through all furnace and boiler tubes prior to firing the unit. Expansion movements of as much as 8 in. verti-

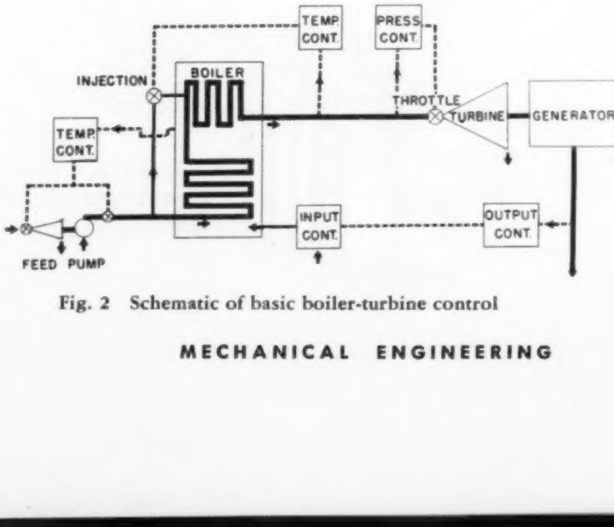


Fig. 2 Schematic of basic boiler-turbine control

cally and 5 in. horizontally obviously become a matter of significant consideration. Controlled recirculation also makes possible the uniform heating and cooling of the thick-walled heavy drums in these large high-pressure units which are so important in both normal and emergency starting and shutdown.

Considerable operating service with high-capacity recirculation pumps of both injection and submerged-motor types has now eliminated the concern first felt on the use of this equipment.

The use of small-diameter relatively thin wall tubes is a natural development in the use of forced circulation. About 40-psi pressure head is provided in the controlled-circulation pumps, or almost 5 to 7 times that normally calculated as available to produce the circulation in a large natural-circulation boiler at 2400-psi turbine-throttle operation.

Typical Monotube Installation

Typical of the possibilities of the monotube once-through installation at high subcritical pressures is the Portland unit of Metropolitan Edison Company. This unit has a capability of 175,000 kw with a throttle pressure of 2520 psi with moderate steam and reheat temperatures of 1050 F.

The economic analysis of the supercritical cycle gives reasonably clear indication that within the next few years a large proportion of new utility units will be for operation in the range of 3500 psi.

The 358-mw No. 2 unit for Eddystone was designed for this cycle. The boiler will generate 2,178,000 lb of steam per hr with 3500 psi and 1050 F at the turbine throttle. There are two reheats, the first at about 1000 psi and 1050 F, the second at about 300 psi and 1050 F.

Modern Steam Generator Designs

By D. R. Wilson, Assistant Chief Engineer, Boiler Design, Boiler Division, The Babcock & Wilcox Company, New York, N. Y.

The first commercial supercritical-pressure steam generator placed in service at the Philo Plant of Ohio Power Company on March 20, 1957, has surpassed all expectations for boiler availability, performance, ease of operation, and freedom from troubles pertaining to the once-through principle. The possibilities for reduced capital and operating costs, and the simplicity of operation with excellent steam-temperature characteristics over the operating range point to an increasing trend toward subcritical and supercritical units of this type in the near future [1, 2].[1]

Structural-Design Trends

The trend toward the general use of single-boiler single-turbine installations in central stations has resulted, in part, from the fact that boiler availability increased to a level comparable to turbine availability. This has been remarkably improved by the use of tangent-tube furnace-wall and flat-stud tube-wall assemblies, eliminating almost completely the use of refractory materials which are subject to excessive maintenance during outages [3].

In a typical modern furnace-wall section of tangent-tube construction, Fig. 3, the basic sealing requirement is provided by a gas-tight seal-welded inner casing in contact with or in close proximity to the pressure parts. A single layer of block insulation provides an optimum solution to the temperature-reduction problem. With this combination, the outer covering no longer acts as a seal, and light-gage metal-lagging designs have been developed and are coming into use which are suitable for both indoor and outdoor installations.

Complete elimination of rolled-tube joints in drums and headers of high-pressure units, almost complete elimination of gasketed joints, and improved welding techniques in both shop and field are other major factors contributing to high boiler availability and reduced maintenance costs.

[1] Numbers in brackets designate References at end of paper.
Condensed from ASME Paper No. 58—Pwr-16.

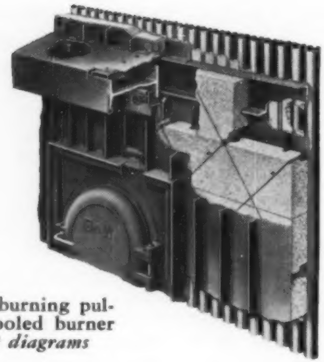
Pulverized-Coal-Fired Designs

Conventional-fuel-burning steam-generating plants patterned after present-day progressive designs will provide, by far, the major portion of the predicted capacity increase during the next 15 to 20 years. A modern steam generator which has been in service at the River Rouge Plant of the Detroit Edison Company since February, 1956, delivers 1,720,000 lb of steam per hr to a 260,000-kw turbine, is one of the largest in service to date, and typifies the trend to higher duty and higher capacity. Operating at 2051 psi, the primary steam temperature, 1050 F, and the reheat steam temperature, 1000 F, are controlled over a wide load range by means of gas recirculation in conjunction with gas proportioning over the superheater and reheater surfaces, and superheater spray attemperation. This pulverized-coal-fired boiler features a single furnace with a division wall and a dry-bottom cross-hopper having a shielded arrangement. Spaced circular-type burners are arranged to fire coal, oil, or blast-furnace gas in conjunction with coal.

The slag-tap pulverized-coal-fired unit, installed in the Burlington Station of the Public Service Electric and Gas Company, was placed in commercial service in October, 1955. Designed for 2700-psi, this unit delivers 1,225,000 lb of steam per hr to a 180,000-kw turbine at 2390 psi and 1100 F at the superheater outlet, with reheat to 1050 F.

Wide-spaced radiant-superheater platens provide a much flatter steam-temperature characteristic than could be attained with only convection surface. The high primary and reheat steam-temperature conditions require a very high percentage of the total-unit heat absorption in the superheater and reheater; and gas circulation to temper the combustion gases and prevent slagging of the radiant platens is a design feature which has proved satisfactory in operation. Without gas tempering, an appreciable load reduction is required on the unit to prevent excessive slagging of the radiant-superheater platens.

design trends



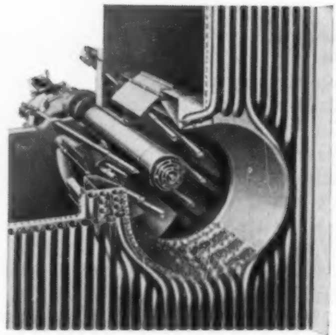


Fig. 3 Tangent-tube wall constructed inner-cased, with block insulation, and outer metal lagging, *left*

Fig. 4 Circular tri-fuel burner capable of burning pulverized coal, oil, and gas with water-cooled burner throat and automatic oil lighter, *two right diagrams*

The foregoing units are fired by circular-type burners, Fig. 4. Capable of firing pulverized coal, oil, and gas, singly or in combination, the turbulent mixing characteristics of this type burner provide excellent ignition stability over a wide load range on all fuels. The burner throats are completely water-cooled, being covered only with a thin layer of refractory, retained by pin studs, to provide smooth throat contours so that maintenance requirements are practically eliminated. Ring-type gas burners which are inaccessible for repair or cleaning while in service, have been replaced by new multispud gas burners which are removable for either cleaning or repair with the unit in service. Automatic oil and gas-lighter development work has resulted in designs insuring dependability; and all burner adjustments, during start-up, shutdown, and normal operating periods can be remotely regulated from centralized control rooms.

Cyclone-Furnace Designs

The cyclone furnace is the result of continued efforts to improve the methods of burning fuels, to better the functional design and performance characteristics of boilers, and to minimize the problems of air pollution [4]. As shown in Fig. 5, the cyclone furnace is a horizontal water-cooled cylinder of tangent-tube construction in which the complete combustion of fuel takes place at inputs per cyclone ranging to 500,000,000 Btu per hr. Crushed coal, gravity fed to the burner, is mixed with the primary air stream and deposited on the slag lining where rapid surface burning by a high-speed tangentially admitted secondary air stream occurs. A new development, the vortex coal feed, greatly reduces the back pressure on the coal feeders and eliminates costly rotary seals. Depending on the primary-furnace design, 80 to 85 per cent of the ash content of the coal is tapped from the cyclone and then through primary-furnace floor openings in molten form to water-filled slag tanks for quenching and disposal. Refiring of fly ash, collected from the products of combustion after discharge through the cyclone re-entrant throat and passage through the boiler unit, is utilized to completely eliminate the nuisance of fly-ash handling and disposal.

The cyclone method of firing simplifies the burning of gas and oil at ratings and with performance equal to coal firing. Gas is fired through ports integral with the secondary-air entrance and oil is introduced at low pressure, 50 psi, by a roof-type burner which consists of a perforated pipe across the secondary air ports and which remains in firing position at all times. During an interruption in coal supply, the roof-type burner can be placed in full-load service in a few seconds. A gun-type oil burner, inserted axially through the burner front, is used for long-term oil-firing periods but must be removed during coal-firing periods to prevent tip fouling. The burning characteristics produce a longer flame travel from the re-entrant throat which tends to increase steam-temperature control range.

This significant advance in the art of burning coal numbers among its advantages the ability to handle a wide variety of coals with very low excess-air requirements and low carbon loss; appreciably reduced stack-gas dust loading; thus facilitating the reduction or elimination of dust collectors; and the elimination of fly-ash erosion of tubes. The cyclone method of firing reduces appreciably the number of interlocks, controls, and lighters since a single cyclone can burn about four times the amount of fuel fired by typical pulverized-coal burners. Simplicity and reliability of operation are excellent and, to date, a furnace puff or explosion has never occurred on a cyclone-fired unit when burning coal.

This principle of firing is now being applied to a high-

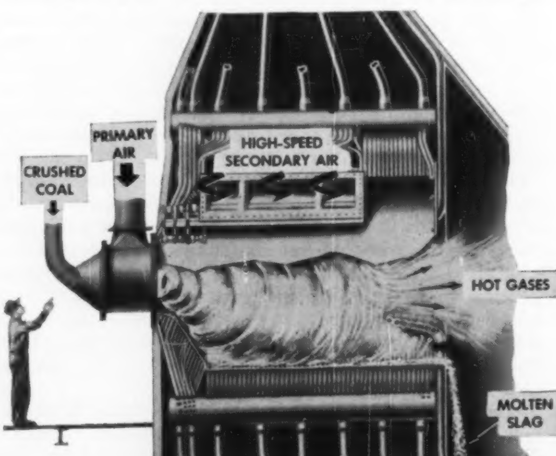
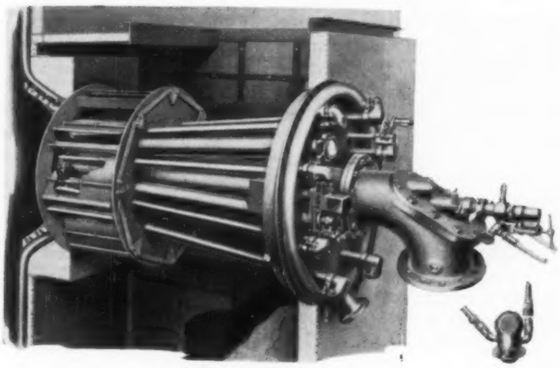


Fig. 5 The cyclone furnace, a horizontal water-cooled cylinder of tangent-tube construction



capacity steam generator being erected at the Joliet Station of the Commonwealth Edison System. Designed to generate 2,200,000 lb of steam per hr at 2100-psi and 1055 F, with reheat to 1005 F, this unit will serve a 325,000-kw turbine. Nine cyclone furnaces are arranged for opposed firing in a single furnace and this opposed-firing feature will be utilized frequently as unit sizes increase. The arrangement of the unit features completely drainable pressure parts, and the trend toward increased use of wide-spaced radiant-superheater and reheater platens is incorporated in the design to provide relatively constant steam temperature over a fairly wide load range.

Pressure Furnaces

Pressure-furnace operation of steam generators in central stations continues to gain in popularity. This significant design advance was made possible by the development of a gas-tight inner casing (now of a feature of most modern nonpressure units as well). The success of this feature was contingent on the casing temperature closely paralleling the pressure-part temperatures under all operating conditions so as to reduce stress. Compared to the older conventional settings with their attendant room-air infiltration, a pressure-cased boiler operating with only forced-draft fans offers a gain in boiler efficiency in the order of 0.3 to 0.5 per cent. Pressure-furnace operation offers definite advantages such as the reduction in total fan power, due to the smaller volume of relatively cold air handled by the forced-draft fan, and the elimination of induced-draft fans and their attendant maintenance. Operation is simplified since it is not necessary to maintain a balance between the forced and the induced-draft fans. A definite trend to pressure-furnace operation and elimination of induced-draft fans prevails on gas and oil-fired units and on units with cyclone furnaces since they are ideally suited for this mode of operation. This trend is not too apparent in pulverized-coal-fired installations due, in part, to the necessity of double valving a large number of burner lines and other sealing requirements.

Steam Purity

With the trend to higher and higher operating pressures, the problem of turbine-blade fouling by tenacious silica deposits becomes acute, resulting in loss of efficiency and capacity. Mechanical separating equipment is ineffective since silica is carried out of the boiler in gaseous solution. Silica solubility in steam increases rapidly with higher saturation temperatures—an increase in operating pressure from 2000 psi to 2800 psi, for example, increases the vaporous silica in the steam five times.

Generally, 0.025-ppm, or less, silica content in steam is considered good practice. Drastic reduction in boiler-water silica concentration at high pressures would be required to comply with this limitation. To decrease blowdown requirements and the need for almost silica-free water, units operating at high pressures are equipped with highly effective steam washers. Cyclone steam separators provide for the primary separation of steam from the steam-water mixture, and primary-steam scrubbers above the cyclones remove entrained-moisture droplets. The steam then enters the washer arrangement

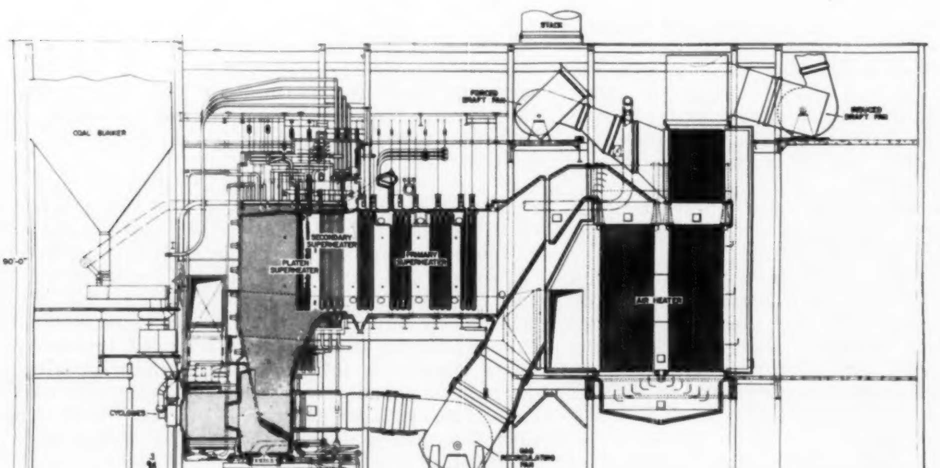
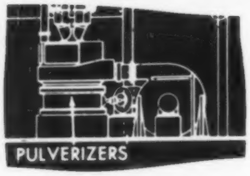


Fig. 6 The cyclone furnace at the Philo Plant of the Ohio Power Company serves a 125,000-kw turbine and generates 675,000 lb of steam per hr at 4500 psi, 1150 F



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passing consecutively through a perforated steam-distribution plate, a stainless-steel wire pack, a perforated water-distribution plate, and a corrugated secondary-moisture eliminator. Wash water is distributed above the upper distribution plate and flows downward countercurrent to the steam flow.

The extensive surface of the wire pack, providing very large surface contact between steam and wash water, and violent agitation of wash water on the trays by the high steam mass flow results in maximum silica reduction over a wide load range. At full boiler load, with the wash-water flow approximately 5 per cent of the feedwater flow, the steam washer will remove 75 per cent of the steam-dissolved silica. Water for the steam washer is taken from the feedwater header and the control system is simple and requires no operator attention.

Universal-Pressure Boiler Designs

Thermal gains in steam-electric plants can best be effected by increased steam pressure and temperature. One of the greatest advances in this regard was the development of the first supercritical-pressure boiler for power generation in this country. The cyclone furnace unit at the Philo Plant serves a 125,000-kw turbine and generates 675,000 lb of steam per hr at a pressure of 4500 psi, and a temperature of 1150 F, Fig. 6. The steam is reheated twice—to 1050 F and 1000 F.

Two considerably larger supercritical-pressure units are scheduled for installation in the American Electric Power System. Each unit will serve a 450-mw turbine and deliver 2,900,000 lb of steam per hr at 3500 psi and 1050 F, with two stages of reheat to 1050 F. The Sporn Plant unit is designed for pulverized coal firing, and the Breed Plant unit of the Indiana-Michigan Electric Company is designed for Cyclone-Furnace firing.

In the subcritical-pressure range from 2400 to 3000 psi, in unit sizes of 175,000 kw and larger, the once-through unit has definite advantages, as compared to drum-type boilers, due to elimination of the heavy drums and downcomers, the reduction in support steel, the over-all weight, and the simpler controls.

Two Universal-Pressure steam generators scheduled for installation at the Huntington Beach Station of the Southern California Edison Company will each supply 1,638,000 lb of steam per hr to a 200,000-kw turbine at 2450 psi and 1050 F with reheat to 1000 F. Firing is by the circular-type oil and gas burners, arranged in two levels in all four furnace walls.

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Trends in Present Day Boiler Design

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Once-through steam generators should become more numerous in the U. S., since they have advantages in lower weight, control of steam temperature over full load range, possibility of variable pressure and temperature operation, and rapid start-up and shutdown procedures. On the other hand, their selection over the more conventional types of boilers involves economic consideration of requirements for more sensitive control equipment, greater pump power, high-purity feedwater, more condensate storage, and the necessity for a bypass line heat-exchanger system.

Operating experience with supercritical pressures that will affect future designs of once-through steam generators is being obtained in the Foster Wheeler Cartaret pilot plant [5]. This steam generator has a capacity of 2000 lb per hr of steam operating up to 5500 psi and 1200 F. Since 1956 this plant has operated 5000 hr. Feedwater treatment and corrosion rates have been investigated, and control systems for commercial once-through steam generators have been studied.

Principal Types

Once-through steam generators for supercritical as well as subcritical pressures are of two principal types, the Benson and Sulzer. A Benson-type design for subcritical pressure has a capacity of 1,800,000 lb per hr at 2400 psi and 1050/1050 F. Important in correct design of this type unit are: (*a*) Provision for frequent collecting, mixing, and redistribution of fluid along the complete flow path from inlet to outlet; (*b*) low furnace heat-absorption rates and uniform heat distribution to fluid circuits; (*c*) final evaporation or conversion zone located in low gas-temperature sections; (*d*) drainable pressure parts.

At supercritical pressures, and at subcritical pressures within 400 lb of the critical pressure of 3206 psi, forced circulation is required for the once-through type of unit. At lower pressures a choice can be made between natural circulation and pump circulation. Fortunately, it has been the practice for many years to calculate the circulation of new boiler designs. This background and the close agreement that has been obtained between predicted circulation and actual measurement permits the designer to confidently predict and design for natural circulation at high subcritical pressures with ample safety margins in spite of the reduced circulating force available.

Criteria used as basis for natural-circulation design are: (*a*) A limitation on the per cent steam by volume in the steam-water mixture leaving heated portions of

Condensed from ASME Paper No. 58—Pwr-17.

furnace or boiler tubes at maximum capacity, usually 65 to 85 per cent steam by volume depending on pressure and type of circuit; (*b*) velocity of water entering the heated portion of tubes at least 1 to 2 fps, also depending on pressure and type of circuit; (*c*) separation of steam and water in drum to give steam-free water in downcomer supply; (*d*) segregation of circuits with differing absorption rates.

An advantage often cited for natural circulation is its self-compensating effect. If absorption rate is somewhat higher than predicted because of miscalculation of friction loss, localized hot spots, or other unforeseen circumstance, the average density of the circuit is reduced and flow to the circuit increases.

As operating pressures increase there is a rapid increase in the per cent of silica that will vaporize and be carried over with the steam to deposit on turbine blades. Generally acceptable limits of silica in steam are below 0.025 ppm, achieved through close control of silica concentration in boiler water by feedwater treatment and blowdown. Mechanical separators will not remove silica after it has vaporized in a boiler, but it can be reduced by washing with incoming feedwater. Being low in silica it will dissolve a portion of silica vapor from steam passing through it, depending on degree of mixing and the purity of feedwater. The dual-circulation principle is another approach [6], whereby concentration of silica (and total solids) in the boiler water from which steam is generated can be maintained at much lower values. In a conventional boiler, all boiler water comes from a common downcomer system and results in uniform solids concentration entering all sections of the boiler. In a dual-circulation boiler, the arrangement of feedwater-intake and downcomer-supply circuits is such that the steam generator has two separate circulating systems, and solids concentrations are no longer uniform. The boiler-water concentration in the secondary section is maintained at or above the recommended limits of the American Boiler & Affiliated Industries. Due to the dual-circulation principle, the resulting boiler-water concentration in the primary will be about 50 to 25 per cent less depending on the design. Steam generated from the low-concentration primary section will have correspondingly less silica vapor and total solids. Steam generated from the higher-concentration secondary section will be all or partly condensed by contact with incoming feedwater so that this steam contributes little if any to the impurity of saturated steam passing out of the boiler.

An 1850-psi dual-circulation reheat unit, Fig. 7, has two primary sections, the first being furnace side and division walls, and the second being furnace rear wall. The secondary section is comprised of boiler and wall surface in the convention pass. Connections for recirculation between the sections permit flexibility in chemical control of various constituents. Test results show less than 0.005 ppm silica in steam while silica range in primary was 0.2–3 ppm and in secondary 5–10 ppm.

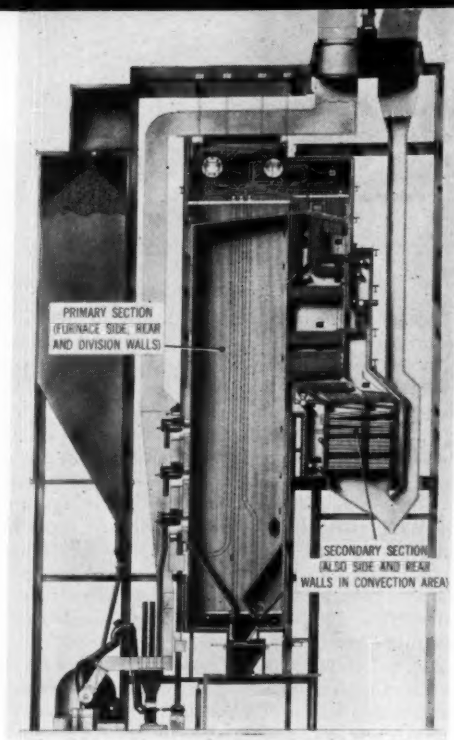

Fig. 7 A reheat steam generator employing the dual-circulation principle with 1,450,000-lb-per-hr steam capacity at 1850 psi and 1000/1000 F

Temperature

The trend toward increasingly higher steam temperature is at present temporarily halted by lack of suitable materials. Metals for steam temperatures of 1050 F are generally accepted as giving satisfactory service life, although temperatures higher than this are being employed.

The development of steam generators which provide wide-range and close control of steam temperatures is continuing. It is possible to design large steam generators which provide steam at any desired temperature level between maximum design temperature and saturation, or reheat inlet temperature, over wide ranges of load. This involves a multiple-furnace design having separate superheat, reheat, and water-evaporating furnaces, but cost is not competitive.

There are a number of principles which can be applied to more conventional steam generators in order to provide wide ranges for constant temperature control. These include use of radiant surfaces for superheating and reheating, gas recirculation, and flame-shift methods. Radiant steam-heating surface, in use by the author's company for over 40 years, presents the steam generator designer with two useful tools [7]. The steam temperature leaving this surface decreases with increasing load. Also, by placing a portion of the superheater or reheater surface in the furnace, the steam-heating duty remaining for convection surface is less and gas temperature leaving the furnace can be reduced below that for all-convection surface.

In a typical design, the radiant superheater forms the front firing wall, hopper slope, and roof. Other recent designs have incorporated radiant steam-heating surface in full and partial division walls, in side-wall panels, or interspersed with water-wall tubes in side walls.

Capacity

There is a continuing trend to ever-increasing capacity in a single unit. Some of the larger units are of double-furnace type while others retain the single-furnace form. In either case, design for the larger capacities requires special attention to support of the long spans, drum size, and lengths, accessibility for cleaning, and

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uniform distribution of both heat and flows throughout the unit.

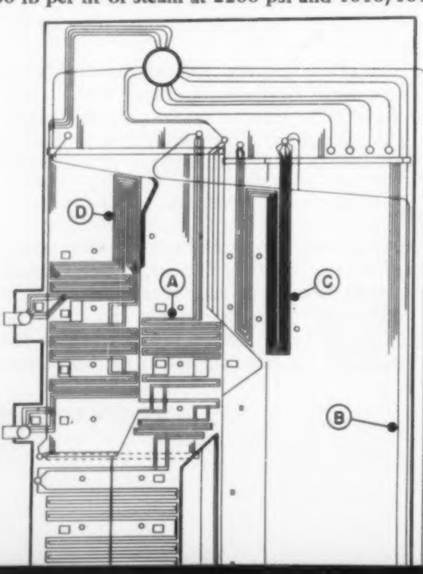
Size of such auxiliaries as pulverizers, firing equipment, regenerative air heaters, and fans are also increasing. Designs for ball-mill pulverizers, for example, are being prepared with capacity approaching 100 ton per hr on a favorable coal, although the largest mill being built has a capacity of 46.5 tons per hr.

Large capacity has increased the incentive of designers to proportion heating surfaces for optimum use of available temperature levels. As the total amount of surface increases, substantial dollar savings can be realized by placing heating surface in the most advantageous temperature zone at the expense of some complication.

A recent example is a 2,350,000 lb-per-hr reheat steam generator with 2200 psi, 1010/1010 F conditions, Fig. 8. Saturated-steam connections from the drum form the rear wall of convection pass and enter a section of convection superheater *A;* this places the lowest steam temperature in the lowest gas-temperature zone preceding the economizer, and results in optimum-mean-temperature difference. Steam then passes through the radiant superheater *B* located on front wall and roof of the furnace. This incorporates the radiant characteristic into the superheater, reduces the gas temperature required at furnace exit, and reduces the duty required of the finishing section *C* of the superheater. As a result, the gas temperature entering the reheater *D* is at high enough level to give advantageous heat-transfer rates without high furnace-exit temperature. The amount of superheater surface in the first convection section, radiant section, and the finishing section can be apportioned for optimum balance of metal temperature and mean temperature difference between gas and steam.

With this arrangement, control of steam temperatures is obtained by proportioning gas flow between the two parallel gas passes by means of dampers located at outlet of economizer, plus a feedwater tempering spray or condenser in the superheater. The duty represented by the difference between the uncontrolled temperature and the controlled temperature is shifted from superheater by control of gas flow in the two parallel passes *A* and *D*. By this means the control range of the reheater is increased without additional surface.

Fig. 8 A single-furnace steam generator for capacity of 2,350,000 lb per hr of steam at 2200 psi and 1010/1010 F



Efficiency

The various means available or contemplated for attaining higher steam-generator efficiency through lower exit-gas temperature usually involve adding heat-recovery surface in the temperature range where corrosion and plugging of the surface will occur. Evaluation of the initial cost and operating expense of such surface has so far justified the resulting higher efficiency in only a few power stations.

Provisions must be made to maintain effectiveness of this heat recovery without removing the steam generator from service. This usually requires a system for in-service washing, and fabrication of exposed metal surfaces from alloy steel, cast iron, or noncorrosive material clad to metal surface. Investigation now being pursued, that appears to provide greatest benefits in this regard, is ammonia injection into flue gases to reduce corrosion by preventing the formation of H_2SO_4 from sulfur-bearing fuels.

Erection

In recent years there has been an increased use of shop prefabrication in order to realize the savings that result from lower shop-labor costs compared to field-labor costs, from the superior quality control obtainable in a manufacturing plant, and time saved on field erection. Greater use is being made of panelized tube-wall sections, sectionalized superheaters, reheaters and economizers and flue and duct assemblies, and other prefabrication techniques.

A recent development in this direction is the integral-fin wall construction shown in Fig. 9 with the fins welded continuously between open-spaced tubes to form a solid wall. An integral-fin section using $^3/_4$-in-wide fins has only about 80 per cent of the weight of a comparable panel of tangent tubes with skin casing.

Two units with the integral-fin wall have been placed in operation this year. Each has a capacity of 445,000 lb of steam per hr at 1360 psi and 950 F.

Three natural-gas-fired pressurized reheat units which also make use of the integral-fin design are now being fabricated. These units range in capacity from 1,550,000 to 2,150,000 lb steam per hr.

Combined Gas-Steam Cycles

The use of gas turbines in power generation has received considerable study in recent years, including their use in combination with steam boilers. There are at present few installations of this kind, but we believe their use will find increased favor in years to come. The steam generators used in the combined gas-steam cycle present interesting design considerations.

One such cycle makes use of exhaust from gas turbines as combustion air supply for a conventional steam boiler [9]. The boiler can be designed for the firing of solid, liquid, or gaseous fuels. A steam generator for this cycle is now nearing completion for a southern utility as part of a 40,000-kw combined gas-steam cycle.

Another type of steam generator being considered for gas-turbine applications is the supercharger boiler [10], which takes the place of the gas combustor. Atmospheric air compressed to over 70 psi enters the supercharged boiler where combustion of fuel takes place. Gas discharge from the boiler is at the high pressure and temperature required to operate the gas turbine.

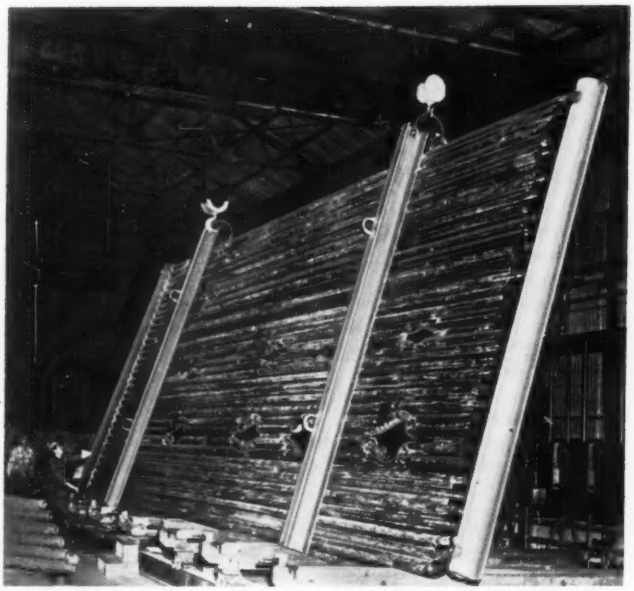


Fig. 9 Factory-assembled water-wall panel of the integral-fin type ready for shipment to the field

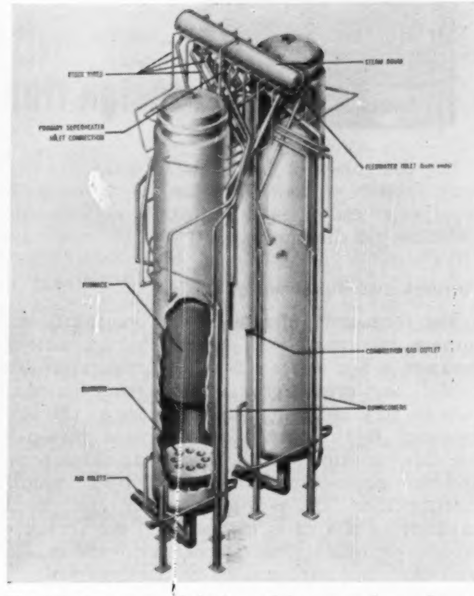


Fig. 10 A proposed design of the supercharged type for the combined gas-turbine steam-turbine

Supercharged boilers in operation at present have capacities on the order of 150,000 lb steam per hr and are limited to use of natural gas or light-oil fuels. Some progress has been made in overcoming the problems associated with firing residual oil and coal, but these fuels are not yet ready for commercial use in supercharged boilers.

Fig. 10 shows a reheat unit proposed for 133,500-kw installation and would produce 735,000 lb steam per hr at 1800 psi, 1000/1000 F. This is a natural-circulation, twin-furnace boiler using differential firing to control primary and reheat-steam temperature. The supercharged boiler is characterized by furnace-heat-release rates and heat-absorption rates on the order of 3 to 4 times higher than normal for conventional steam generators, and therefore occupies considerably less space per lb of steam generated than a conventional boiler. This unit, for example, consists of two 15-ft-ID shells and has a floor space including supporting steel and platforms of 30 × 50 ft with an over-all height of 100 ft.

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Design Requirements for Steam Generation with High Cost Fuels

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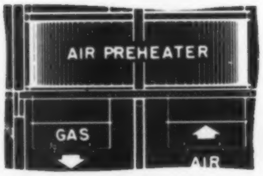
The design of steam-generating units for use in areas of high fuel cost involves a number of interesting problems. Among these are: The necessity to design for more than one fuel; the economic justification of high turbine-cycle efficiencies involving the use of higher pressure and temperatures; the need for high efficiency of the steam-generating equipment; the necessity for continuous availability; the requirement that the units operate at the maximum efficiency within the design capability.

Condensed from ASME Paper No. 58—Pwr-15.

Multifuel Design

Areas of high fuel cost usually have more than one fuel which can be economically justified, although in the past this has involved considerable additional investment. Designs are now available which minimize this additional investment and provide for the efficient use of a variety of fuels with no expensive alterations when changing from one fuel to another. In these, the same furnace performance is available with different fuels and consequently the same range of steam-temperature control is possible without costly auxiliary equipment.



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The designer's problems when designing for two or more fuels begin with the furnace, continue with the superheater and reheater and on through the unit to the airheater gas discharge.

Furnace and Superheater Design

The furnace requires sufficient cooling to reduce the furnace exit gases well below the ash-softening temperature. The increase in steam temperatures to 1000 F, 1050 F, and even higher, focuses attention on the variation in tube-metal temperatures across the width of a furnace. If the metal is to have a reasonably long life this variation must be kept to an absolute minimum, and the methods of firing must produce a uniform gas distribution. The problem is more pronounced as the capacity of the units increase and the furnaces become wider, requiring close attention to the maximum furnace-exit temperature as related to the average.

One satisfactory solution is the use of water-cooled platens within the furnace section. These platens are formed by rows of tangent tubes spaced across the upper furnace to form a number of passages which can be variously disposed to suit the design requirements. The location is above the zone of active burning so there is no interference with combustion. This construction furnishes the designer with a flexible tool in designing for a required furnace exit-gas temperature by placing more or less radiant surface between the active combustion zone and the superheater entrance. The platens also absorb heat at intervals across the furnace between the walls, thus reducing the amount of gas-temperature variations and the possibility of slagging. Superheater tube-metal temperature measurements with this type of construction range from 1035 to 1050 F, with 1000 F final temperatures even in wide furnaces.

Furnace volume is important in providing sufficient space for flame development and completion of combustion. It is also important in providing the necessary time for the water-cooled surface to cool the gases before the furnace exit. If the furnace-residence time is too short, the gases cannot cool to the required level. The designer when confronted with two or more fuels must design a furnace for the one requiring the greater volume. The larger units in the New England area burning pulverized coal and oil should have furnaces designed for a volume heat-liberation rate of approximately 18,000 Btu per hr per cu ft of volume and no higher than 85,000 Btu per hr per sq ft of projected furnace surface.

The maintenance of steam and reheat temperatures over an economical range when designing for two fuels requires care in selection of the amount and disposition of superheating surface. The amount of required surface varies with the different fuels and is usually least for natural gas and highest for oil with coal falling between. It might be that no economy would result from operating with a second cheaper fuel, such as oil, if the superheater surface has been sized for coal, because the resulting lower steam temperatures would tend to offset any saving. It is essential to design for approximately the same temperature range with all available fuels. This problem is simplified by the use of intermediate radiant surface in the form of a platen superheater in the furnace. The superheater surface is disposed as radiant platens widely spaced across the width and water-cooled platens are used in the upper furnace.

Heat Recovery

The design of heat-recovery equipment, particularly the air heaters, requires special care where two fuels are available. The high-cost fuel makes low air-heater exit temperatures mandatory, but the heater surface must be protected against corrosion, especially that resulting from attack by sulfur compounds. If oil with sulfur as high as 3 per cent is burned, larger amounts of air recirculation requiring larger fans, larger heating coils, or possibly a combination of both will be required.

Careful selection of economical operating pressures and temperatures for the turbine and steam-generating equipment is always essential but even more important when considering units subject to high fuel cost. The general trend to higher pressures and temperatures is most marked where fuel prices are relatively high.

Similarly, the need for continually higher steam-generating efficiency is obvious and mandatory in high-fuel-cost areas. As we become intrigued by the thermal gains obtainable with high pressures and temperatures, we tend to forget the less spectacular but equally valuable gains which can be obtained by reducing the final exit-gas temperatures.

Air-Heater Protection

A decrease in air-heater exit-gas temperature is accompanied by an increase in the rates of heating-element corrosion and deposit formation requiring improved cleaning techniques or corrosion control if more efficient air-heater operation at lower exit-gas temperatures is to result. In connection with regenerative air heaters, there has been constant improvement in the technique of cleaning by using air or superheated steam as the blowing medium and by the extensive use of water for washing the heating elements. Techniques and equipment are available for in-service washing which insure maintenance of air-heater efficiency at low exit-gas temperatures.

A somewhat different approach is used in Unit No. 3 of Detroit Edison Company's River Rouge Plant.[2] This installation is equipped with four Ljungstrom air heaters in a series arrangement which are furnished with enameled cold-end heating elements for protection against corrosion from the exposure to sulfur compounds and moisture at temperatures as low as 200 F.

The installation of a stack economizer in the cold gas from the air heater as part of a closed system circulating hot water through air-heating coils at the entrance to the main air heaters is another solution to the problem of operating continuously at low exit temperatures. Such a system acts to raise the average metal temperature of the cold-end heater elements and to reduce the corrosion rate. This water can be at a pressure level which will permit the use of a cast-iron economizer to minimize the corrosion.

Further development in the search for materials to

[2] See W. C. Wingert and R. J. Stanley, "Design of a Large Coal-Fired Steam Generator for 200-F Exit-Gas-Temperature and Operating Experience With Pilot Plant," *Trans. ASME*, vol. 78, 1956, pp. 1393–1402.

Table 1 Comparison of Full-Pressure Operation With Suction Design

	Suction operation		Pressure operation	
Steam, lb per hr	1,200,000	Fan design	1,200,000	Fan design
Air, lb per hr	1,574,000	1,810,000	1,574,000	1,810,000
Air temperature, F	80	80	80	80
Air volume, cfm	366,000	420,000	366,000	420,000
Total static pressure, in. water gage	7.9	10.4	17.2	22.5
Input to fans, hp	650	890	1350	1770
Motors	Two, 450 hp		Two, 900 hp	
Induced-draft fan data				
Gas, lb per hr	1,692,000	1,946,000		
Flue-gas temperature, F	295	315		
Gas volume, cfm	528,000	622,000		
Total static suction, in. water gage	9.4	12.4		
Input to fan, hp	1310	1691		
Motors	Two, 900 hp			
Total input to fans, hp	1960		1350	
Horsepower saving			610	(31%)
Motor saving			Two, 450 hp	

resist this low-level corrosion is proceeding throughout the industry. The use of glass or ceramic materials appears to hold some promise.

Auxiliary Power

The over-all station efficiency is affected by a number of relatively small factors, important in the aggregate.

The magnitude of the auxiliary power required to move the air and gas through modern units suggests the possibility of substantial savings. Operation of the system as a full-pressure design without induced-draft fans will reduce this power appreciably when compared to balanced-draft operation for two basic reasons: First, the volume is less because only ambient air is handled; second, airfoil blade fans with efficiencies ranging from 84 to 88 per cent can be used. Savings with pressurized operation may run as high as 30 per cent at the operating load as shown in Table 1. This shows a comparison of fan-power and motor requirements for a unit having a capacity of 1,200,000 lb of steam per hr. Savings in installed horsepower and auxiliary equipment as well as initial investment and induced-draft-fan maintenance costs are obvious.

The continuing trends to greater capacity and pressures in steam-electric generating stations have created a new interest and need for high-speed steam-turbine drives for boiler-feed-pump service to decrease the demand for auxiliary power.

Similarly, the use of turbine-driven forced-draft fans on pressure-fired units using steam from the low-temperature-reheat steam line would appear economical. Certain applications might require small auxiliary drives for starting from a cold condition.

Availability and Efficiency

The higher justifiable efficiencies and the resulting increased investment costs stress the need for maximum availability. There is no gain obtainable from more efficient equipment if it remains idle. A furnace suitable for the lowest-grade-available fuel and adequate protection of the heat-recovery equipment are essential for economy. Other factors affecting availability are: adequate circulation, careful selection of superheater and reheater metals, wide spacing of heating surfaces to maintain free gas passage, and suitable characteristics of pulverized-coal equipment.

Again there is little justification for highly efficient design unless it is possible to operate the units continuously at their maximum design efficiency.

Automatic Systems

The manufacturers of controls and instruments are continually working toward automatic systems and that other long-cherished ambition of every designer—an automatic push-button plant. Interesting steps toward this achievement are the automatic-data-collection systems now in operation at the Sterlington Station of Louisiana Power and Light Company and Neches Station of Gulf States Utilities.

The following information, published[3] on the equipment at the former station, indicates the trend.

The ADC (more popularly known as DADIT) is installed on 200-mw and 43-mw rated units. It is used to:

1 Scan 250 temperatures during operation of the units at a rate of 5 points per sec. The points scanned are: the bearings and bearing oil on the main unit and auxiliary equipment; boiler, superheater, and reheater tubes; condensate steam; transformers; and other points important to reliable plant operation. Should any of these temperatures exceed a preset alarm point, the digital reading will be printed out and an annunciator will sound an alarm and identify the off-normal point. Printout of the off-normal will continue during each scan cycle until the temperature is brought back to normal or the equipment in trouble is taken out.

2 Log out in digital form any of the scanned temperatures on demand from the operator.

3 Periodically log, on prepared log sheet, another 100 plant readings necessary for accounting and trouble-shooting records. These include flow, pressure, temperature, and heat rate; electric amps, volts, and mw.

The DADIT system consists of a computer with a 1024-word memory. This equipment can be programmed to give any set of readings required, and can be used to obtain corrective control action for various off-normal points. This latter feature will be utilized on this unit only for testing and experimenting with the computer. The computer consists of solid-state circuitry with some mercury relays.

The most important reason given for installing this unit is to provide operating experience with a type of equipment that will be used in the completely automatic power plant, namely, the continuous computer scanner. The eventual goal is steam and electrical generation operated by automatic equipment and supervised and controlled by the computer which will take over sequential start-up, operation, and shutdown. All maloperation which might normally occur will be avoided and such a system produce test efficiencies as a daily routine.

Conclusion

No spectacular scientific breakthroughs have been described, but rather individual design features of special significance for plants in high-cost-fuel areas. Progress in steam generation and combustion of fuel will be made in the future, as in the past, by continuous improvement and refinement of numerous details.

[3] See Don L. Aswell, "Why We Are Using an Automatic Data Collection System," *Power Industry*, March, 1958, vol. 74.

INDUSTRIAL

THERE ARE NEARLY 300,000 manufacturing plants in this country. About two thirds of these, and the ones which we tend to think of as representative of manufacturing, use little energy. They spend more for electricity than they do for heat energy. They purchase their electricity and are tending to go out of the generating business. These plants, being in the majority, produce the impression that industrial electric generation is a thing of the past. This is not true.

The other manufacturing plants, the basic material producers, are more important than their relatively small number of plants would indicate. Their plant investment makes up two thirds of the total of all manufacturing. They consume three quarters of all of the heat energy and three quarters of all of the electricity used by manufacturing. They spend for new plant about one half of all of the money spent each year for the new plant of all manufacturing. They spend twice as much for heat energy as for electric energy. They are both the largest purchasers and the largest generators of electricity.

They generate some of their electricity and are continuing to add new generators, and to do this more in areas where they also purchase electricity most cheaply. They employ fewer people than the other group, their payroll being only one third of the total payroll of all manufacturing.

The first group of industries, the light-energy group, includes the fabricators of textiles, metals, rubber products, furniture and fixtures, and leather goods, the assemblers of transportation equipment and machinery, the printers and publishers, and the makers of clothing.

The second group of industries, the high-energy group, includes the manufacturers of primary metals, petroleum and coal products, pulp and paper, stone, clay, glass, chemicals, lumber, and food products.

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The Basic Facts

For anyone interested in industrial energy the most important thing to know about a particular company or industry is the ratio of fixed assets to total assets. A high value of this ratio indicates an industry which has installed quite a bit of machinery and which can expect a fairly long payback time on this machinery. The hazards of competition from style changes and modified products are small. Relatively few people are required to operate the equipment, and the use of heat and electrical energy is high. The producers of basic materials, the high-energy group, tend to have a ratio of net property value to total assets of between 40 and 60 per cent.

The shapers of materials, the light-energy group, have a ratio of net property value to total assets of less than 35 per cent. They employ a large number of workers, use relatively little energy, and face stiff and quick competition of style changes and new products. Their inventory costs and current asset requirements are high. They cannot afford to lose flexibility by tying up much of their total assets in fixed plant, and require a quick payback on the plant investment which they do make.

Where energy cost is a significant part of its manufacturing cost, an industry will tend to locate in places where fuel costs and electric costs are low, and in addition to buying low-cost electricity will also generate some itself.

Industrial electrical generation is greatest in areas of low fuel cost and consequent low purchased-power rates because the basic material industries tend to locate in such areas. They are the industries with long enough payback time and high enough heat-energy demands to justify their own generation in part or in whole. How-

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POWER *is Different!*

Industrial power requires a different approach than electric utility power, with more attention paid to capital costs than to operating efficiency

ever, in government power areas where purchased-power rates are lower than fuel costs would permit, industry cannot justify installing as much of its own generation.

The relative magnitude of industrial energy can be visualized by comparing it with the electric utility industry. The fuel bill of all the manufacturing plants runs about three times as much as the fuel bill for all the investor-owned electric utility companies. Manufacturing consumes about one half of all the electricity produced by the utility companies and itself generates an additional one quarter of the total electricity which it uses.

Once Upon a Time

The industry of 150 years ago used mechanical energy supplied by water wheels. Mill management had to invest capital in whatever power equipment was required to run the factory. It was impossible to determine the profit made on investment in power equipment. Power could not be separated from manufacturing, and there were no alternate choices on power supply.

Steam power became available 100 years ago. It added heat as a second form of energy tool for industry. It also provided for the first time an alternate way of producing mechanical energy. From that time, whenever industry needed mechanical power it looked at the economics of steam engines as compared with hydro power. The steam engine won more often than it lost, and gradually picked up most of the industrial mechanical load. In the new field of industrial heat there was still no alternate to steam boilers.

Then, 50 years ago, electric transmission appeared, providing the one essential tool for the birth and growth of our electric utility companies. Industry now had three choices for supply of mechanical and electrical energy: steam engines, water wheels, or purchased electricity. Ever since then, economics has determined which source of mechanical and electrical energy would be used by industry. This has not been true for heat energy.

The electric utility business is different in one important way from all other industry. Its requirements for current assets are very low. Most of its capital is in fixed assets of plant and equipment, permitting a long payback time compared with that of most other industry.

Today, electric generation by industry can be justified only under certain conditions. Industry's problem in justifying new electric generation is largely due to the short payback time required on that portion of total capital which most industry can put into its fixed assets, compounded by the effect of the corporation income tax.

The electricity generated by industry has continued to increase, but at a slower rate than industry's electric load. On the other hand, industry still continues to generate essentially all of its heat energy required, just as it did 50 years ago.

Payback—What It Means

How do we calculate payback and what does it mean? Consider the totals of all manufacturing companies for 1956. If we deduct costs and expenses, exclusive of depreciation, from sales revenue we get a figure of $37 billion added by plant for that year. This was made possible by a plant investment, or fixed assets, of $79 billion. Dividing the latter by the former, we find 2.1 years payback average for manufacturing that year. This corresponds to a capital charge of 47.5 per cent.

For the electric utility companies in 1956, by the same type calculations we find a payback of 6.5 years or a capital charge of 15.4 per cent.

Now, the shorter the payback time for the capital invested in plant for a particular company, the harder it will be to justify new power-supply equipment. In boom times they want all their annual depreciation money for building new plant, or for new machinery to increase output—not to obtain cheaper steam or electricity. In

slack times, if not too bad, more depreciation money is available for power-supply equipment; with longer payback time, it is easier to justify.

Variations in fuel costs are relatively unimportant in the face of a great range in capital charge. Utilities' most modern plants run in the order of 9000–9500 Btu per kwhr. Assuming fuel at 27¢ per million Btu, the fuel charge would be about 2.6 mills per kwhr. A manufacturing plant can easily attain 14,000 Btu/kwhr in a small condensing electric plant. At the same fuel cost as above, this amounts to 3.8 mills per kwhr. For manufacturings' by-product electric plant with a heat rate of 5000 Btu/kwhr, fuel charge would be 1.4 mills. This variation of 1.2 mills up or down from the best utility plants is of no consequence compared with the great range in capital charges produced by differences in payback time.

The shorter the payback time, the more important will be capital investment and the less important will be generating equipment efficiency.

The Tax Angle

There is another factor which has been most important in shortening payback times in the last 30 to 40 years. This is the corporation income tax. The utilities, doing about half of their financing by long-term debt, pay out in income tax only about 20 per cent of the "annual value added by plant." Manufacturing, relying mostly on depreciation financing, pays out nearly 40 per cent of its "annual value added by plant" as income tax. This has accelerated the change from industrial electric generation to purchase of electricity.

The income tax has nearly cut payback times in half. The average manufacturing company today has a fixed asset percentage of less than 40 per cent, a payback time of slightly less than 3 years, and finds it hard to justify adding electric generators. If there were no income tax, the present 3-year payback companies would be 5-year payback companies. The present 5-year payback companies are relatively few. It is possible that the income tax has been largely responsible for reducing the percentage of industrial generation by two thirds in the past 40 years. This period has now been long enough so that adjustments may be about completed, and perhaps from now on we will see little decrease in the per cent of electricity which is industry-generated.

Table I Industrial Generation Vs. Purchased Electricity

Type of generation:	By-product noncondensing	Condensing	Hydro
Plant investment, $/kw	$120	$180	$300
Net heat rate, Btu/kwh	5000	13000	
Variable Costs: Mills/kwh			
Fuel charge (27¢/million Btu)	1.4	3.5	
Other operating expense	1.0	1.0	1.0
Total	2.4	4.5	1.0
Capital Charges: Mills/kwh			
3-year payback, 3000 hrs/yr	13.3	20.0	33.0
4-year payback, 6000 hrs/yr	5.0	7.5	12.5
5-year payback, 7000 hrs/yr	3.4	5.1	8.6
3-Year Payback			
Generated cost, mills/kwh	15.7	24.5	34.0
Purchased cost, mills/kwh	14.6	14.6	14.6
4-Year Payback			
Generated cost, mills/kwh	7.4	12.0	13.5
Purchased cost, mills/kwh	9.6	9.6	9.6
5-Year Payback			
Generated cost, mills/kwh	5.8	9.6	9.6
Purchased cost, mills/kwh	8.9	8.9	8.9

The Bigger Item—Heat

Since industry spends more for heat energy than it does for electricity, look at the economics of industrial boiler plants. Included are data on utility payback for comparison.

	Manufacturing plant				Electric utility company
Payback time—years	2	3	4	5	6.5
Hours use per year of capacity	2,000	3,000	6,000	7,000	7,000
Payback hours	4,000	9,000	24,000	35,000	45,500
Capital charge per million Btu in steam ($10 per #/hr of capacity)	250¢	111¢	42¢	29¢	22¢
Fuel charge per million Btu in steam (27¢/million Btu in fuel, 85% boiler efficiency)	32¢	32¢	32¢	32¢	32¢
Importance of capital cost compared with importance of boiler efficiency	7.8/1	3.5/1	1.3/1	0.9/1	0.7/1

Thus a two-year payback industry should be ten times as much concerned with the investment cost of a boiler plant as would an electric utility company, and nearly eight times as concerned with lowering investment cost as it is with improving fuel burning efficiency. Engineers and factory owners are not always aware of this. The lure of high efficiency is apt to be attractive to both.

For a 4000-hour payback industry planning to install a new boiler plant, it should be better to sacrifice 8 per cent in efficiency whenever this will reduce investment by one per cent.

Suppose a 2-year payback industry needed more boiler plant capacity. One possible plant might have 85 per cent efficiency and cost $10 per lb per hr of steam. The alternate plant being considered might be 80 per cent efficient and cost $9.90 per lb. If our ideas are correct, the latter plant should be preferable.

	Plant A 85 per cent eff.	Plant B 80 per cent eff.
Fuel cost per 1000 lb of steam (27¢/million Btu in fuel)	31.8¢	33.8¢
Investment per 1000 lb of steam per hour	$10,000	$9,900
For Plant A :		
Increased investment		$ 100
Saving in fuel cost		2¢/hr
Payback		5,000 hr

The payback period is over the acceptable 4000 hours, so the lower efficiency boiler should be chosen.

To Generate or Not to Generate

Consider the problem of industrial electric generation, and the choice between it and purchased power.

Industries, although their generating plants are smaller, do not have to build a transmission system and they do not strive for maximum efficiency. As a result, the investment cost for industry's electric generating plants is comparable to that for the utilities plant required to deliver power to industry. Table I, although based on average data, provides a rather true picture of the choice which confronts industrial power supply today.

By-product generation can often be justified by companies with a payback time of four years or longer. It is difficult for 3-year payback companies to justify unless they happen to be operating multiple shifts. Condensing electric generation is generally possible only for 5-year payback companies and then only with some combination of lower-cost fuel availability and high purchased-power rate.

Hydro power generation is possible only for companies with a long payback time, plus perhaps a factory remote from low-cost purchased power.

All of these are general statements. There will be exceptions. For example, there still are 3 or 4-year payback mills located away from large utility systems which can still justify new condensing power generation.

People and Their Attitudes

What are the attitudes of the people concerned, and why does industrial management's viewpoint sometimes seem perplexing?

First, imagine the manager of a mill, in a business with a fixed asset ratio of less than 40 per cent, a mill which generates its own steam and some of its electricity. It probably also purchases some electricity. This man ordinarily will not be much concerned with power problems. Out of every hundred dollars which he spends each year for making a product perhaps, he will spend three dollars for steam and electricity. The exact efficiency at which his steam and electric plant is operating will not be too important to him. But, their availability will be of extreme interest. If he has to curtail production because of some equipment breakdown, nothing else will interest him until the equipment is back on the line.

If his power superintendent or a consulting engineer proposes some change or improvement in the power system, he will apply four tests to the proposition. First, he will check to see whether the operating cost savings will retire the capital investment within about 3 years, and preferably less. Though the proposition may fail the first test, his second will be to see whether the operating cost savings will produce enough savings in the unit manufacturing cost of his product to be an advantage in meeting his competition. This is a particularly hard test for power improvements to satisfy, because cost of power is ordinarily such a small part of his total manufacturing cost.

Third will be the question of the necessity: Does his plant require investment in new steam or electric equipment in order to keep running at the product-output rate desired? If so, the new power equipment will be installed. It will, however, be installed for the lowest possible capital cost and with no refinements and no striving for the last point in efficiency.

His fourth test will be to check whether he has money available. He will borrow money only for something of extreme importance to his business.

Next, consider the division superintendent in the industrial plant. He is a man who heads up one of the manufacturing divisions. He has only one line of interest—to make enough of his product to meet production demands, and to have his goods of high enough quality to meet his industry's standards.

In his mind, steam and electric supplies are extremely necessary in whatever quantities and at whatever times he needs them. He is not concerned with their cost: He has no control over it. When he opens a steam valve he expects to get whatever steam he needs out of the line, and to have it at the pressure and temperature he thinks necessary to do the job. If the power-plant superintendent complains that process operating procedures are imposing a hardship on the power plant, the division superintendent will not be much concerned. As far as he is concerned, it is up to the superintendent to give him whatever is required to get out the product.

If he can increase the amount of product which his division is making by using more steam or electricity, either with his present process equipment or by modifications or additions to it, he will think in terms of labor cost and raw material cost. If he thinks at all about the cost of steam and electricity, it will normally be in terms of the operating cost of producing these items. This periodically leads to the situation where increased process demands for the steam and electricity outgrow the capacity of the power supply system. Everyone is surprised when some seemingly small increase in process causes the power system to become overloaded to the point where management is confronted with a large new investment for equipment such as a new steam boiler.

The Power Superintendent

The power superintendent is in an entirely different position. He is apt to feel that no one else in the mill likes him, and that he is fighting alone against management and all of the division superintendents. It seems to him that they expect him to do the impossible.

He knows the mill could not run without the power and steam which he supplies. He knows they cost money, and he often cannot understand how the division superintendents and mill management can be so little concerned with the condition of his power-plant equipment —nor the seeming disregard with which the division superintendents use his electricity and steam without worrying about what it does to his power-plant operations. It puzzles him to see management throw money into new process equipment while he finds it difficult to obtain money for repairs or for more efficient equipment. His natural viewpoint is that of the chief engineer in a utility generating station, though his situation is actually much different.

The power superintendent should accept the fact that management will expect the power-plant equipment to operate with a minimum of maintenance, with a minimum shutdown time for maintenance. Once management has made a substantial investment in something like a new boiler, they expect that boiler to run for a great many years, and are disappointed that they have to spend even relatively small amounts on repairs to it.

The power superintendent may also find that management cannot justify much in the way of stand-by equipment. Thus he is squeezed between the necessity of providing uninterrupted power and the difficulty of obtaining time and money for maintenance and repairs.

All of this adds up to the fact that the power superintendent in an industrial plant has a difficult job, causing him in most cases to find his time fully occupied in keeping his plant running. This is unfortunate, because in every way possible he should try to extend the scope of his work, looking into the process end of the business and concern himself with how his steam and electricity are used in the mill. Any way he can find to improve the efficiency of this use or reduce the amounts of steam and electricity used in the mill—or particularly to have it used in such a way as to increase production—will gain him far more recognition, and help management far more than anything he can do in the power plant. He should try to break down the barrier which normally separates the power-plant people from the process people in the mill.

To make his job even more difficult, he sometimes finds himself and his men saddled with an excessive amount of record-keeping on steam and electrical production. The process divisions, to satisfy management, often require records of amount and cost of steam and electricity used in certain time periods. This information is requested in a form which is sometimes difficult for the power-plant people to work up realistically. The power superintendent should try to work this out with the process people with a minimum of record keeping.

The Consulting Engineer

Now, the consulting engineer. Every so often management decides it would like to have the viewpoint of someone outside the company, someone who is not too close to the multitude of detailed problems and personalities of the company. A consulting engineer is called in and told to make a report on the power situation. Ordinarily this means the steam and electric generation problems; the distribution systems normally are not an important part of the power problem.

The consulting engineer sometimes falls into the trap of looking only at the power supply problem—even worse, of looking at it as if his client were a utility company. This is very apt to cause his findings to be of little interest to industrial management and his recommendations to be rejected.

The consulting engineer must try to think in the same terms as the industrial plant manager. He must realize that in most industries no improvements in the power system are going to reduce manufacturing cost appreciably. Capital for new investment in power-plant equipment is tight and the maximum capacity must be obtained for each dollar invested. Efficiency is not of primary importance.

Because of the difficulty in obtaining capital, and the short payback time required, economies in construction actually may turn out to be less important than a forced schedule of construction to put the new equipment on the line at the earliest possible date.

It probably appears from what has been said so far that the industrial power field may not be a very attractive one for the consulting engineer, and that he perhaps should start each job in it with a feeling he is going to have to work very hard in order to achieve small results. In a way this is true. Industrial power supply problems are several degrees more complicated than those of the utility companies—the multitude of possible combinations and sizes of equipment, combinations of generated and purchased power, all sorts of load-balancing devices between steam and electricity, and various types of electric generation.

In addition, the consulting engineer must reach out into the use of steam and electricity in the mill. If, for example, he can find a way to reduce the use of steam in the mill, or to even out the load swings—or particularly if he can find a way to increase the capacity of some process equipment which was limited in some way by steam or electricity, or its conversion in the process—he will find that he can probably save far more manufacturing cost and arouse more enthusiasm in industrial management than by anything he can do in the power plant.

Keep It Simple—and Rugged

Then, the equipment manufacturer. It appears that he will be most successful in his sales efforts, and in less trouble during the life of his equipment, and will better satisfy management and engineers in all respects if, in the industrial power field, he concentrates on rugged, relatively simple equipment. It appears that it would be to his advantage not to try for extremely high operating efficiency of his equipment but rather to build as much capacity into it as possible for the money. The one other important thing that will endear him to the hearts of industrial management and industrial superintendents is to design his equipment so that it will run as continuously as possible, even when operating under adverse conditions, and so that when breakdowns do occur, repairs can be easily made.

How About the Future?

As more power and automation are added, production workers will continue to move out of the basic material industries into the lighter energy industries, and from there into service occupations. The fixed asset ratio of industry will be upgraded, payback times will become longer, and manufacturing and power supply equipment will be easier to justify.

We are probably only on the threshold of use of power. Our largest manufacturing users of energy are still mostly refiners of natural materials. Basic conversion of materials is still in its infancy, but already is a big power user. Today industry uses heat energy twice as much as electric energy. New methods of power production and new types of energy will probably appear.

When industries start to use really large amounts of energy, electric transmission may not be the answer. Electric transmission costs show no tendency to decrease. Transmission of fossil fuels already is more economical over long distances. Any further decrease in the fuel costs of generating electricity, now down in the 2 to 3 mill per kwhr range cannot have much effect upon power cost. Developments causing lower capital investment for energy supply will be of great importance, particularly to manufacturing with its relatively short payback time. Future solutions will probably be alike in concentrating on the reduction of capital costs.

Increases in system size and the growing complexity of power-plant equipment have resulted in subtle organizational changes. Engineering skills have been upgraded and the opportunities in the field offer a challenge to the best engineering talent.

AN ENGINEERING CAREER IN THE POWER FIELD

By V. F. Estcourt, Fellow ASME

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Some engineering educators hold the opinion that the major problems in the power industry were solved years ago, and that the work is now essentially repetitive in nature with relatively little new engineering content. With respect to power production as distinct from plant design, it has even been suggested that the utilities are users of equipment manufactured by others and, figuratively speaking, all they have to do is keep it clean.

A proper historical perspective is essential to an understanding of the somewhat confused thinking on this subject. The problems of design 30 years ago were extremely simple by comparison with modern plants, and the operating routines were even simpler. The economic pressure for more efficient and more complex heat-cycle arrangements, and the advent of nuclear power have greatly complicated design, operation, and technical management. The challenge offered in the areas of design and production has been steadily increasing, particularly during the past decade; and new and expanding horizons are appearing in all fields of power technology.

It has been emphasized in a previous paper [1][1] that, as a result of advances in equipment and cycle design, greater emphasis must be placed upon the technical problems of operation and management—areas in which relatively little has been published. This is partly because in the past this activity was predominantly an art, and it is only recently that it has emerged as a science. The intangibility of many of the techniques employed today make this material relatively difficult to present as compared with the very tangible monuments arising out of the design of actual hardware. There are no comparable means of displaying the abstract techniques of operations research and other modern management tools.

Influence on Engineering Manpower

The impact of recent technological advances upon existing power-production organizations is considerable. Substantial increases in system size result in subtle organizational changes. As the system grows, the more competent individuals are upgraded, first at the plant and later into central management. The vacancies thus created cannot be filled by replacements in kind because decentralization, dictated by an expanding organization, also requires broadened job coverage at the plant level to include administrative, technical, and decision-making responsibilities formerly assumed at head-office level.

In general, the trend in the field of power generation has been the construction of larger and larger plants with less and less manpower to operate them, and this reflects one of the major technological achievements of the industry. If the same degree of operating reliability is to be maintained, these larger units and increasingly complicated cycle arrangements require centralized controls and an increasing degree of automation. These advances in the art, together with the steady decrease in the number of men on the payroll per kilowatt of installed capacity, have greatly intensified the demand for a better grade of engineer.

An example of the growth of a typical large utility will serve to illustrate what has been taking place manpowerwise. In Fig. 1 a decade of growth in the steam-power facilities of the author's company is illustrated by a plot of the growth in megawatts of capacity and in number of plant personnel. While the capacity of the system was increasing from 627,000 kw to 3,084,000 kw, the total number of men on the plant payrolls increased from 882 to 1096. Thus the number of kilowatts per man ten years ago was approximately 710. Today's over-all

[1] Numbers in brackets designate References at end of paper.

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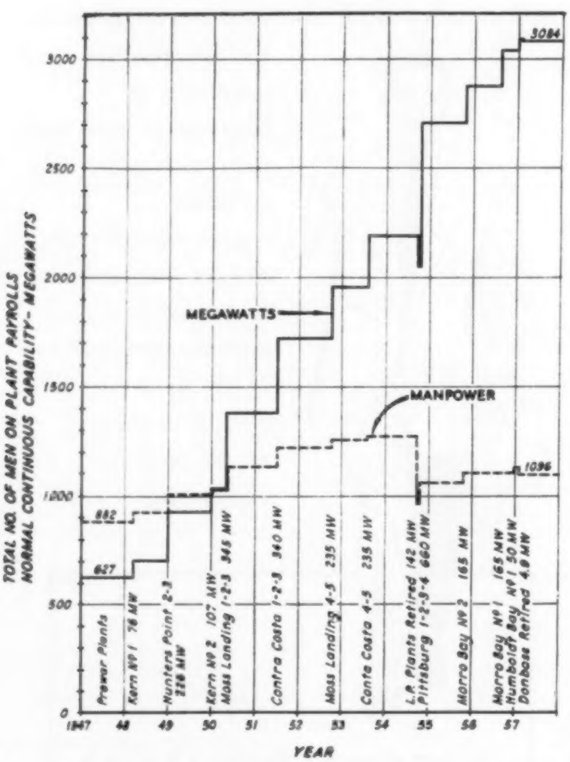

Fig. 1 Growth in steam electric generating capacity and manpower since 1947, Pacific Gas and Electric Company

average is over 2800 kw per man. However, this does not reflect the true picture because it includes most of the older plants with their higher manpower requirements. The incremental figures are more important—an increase of 2,457,000 kw has resulted in a net increase in payroll of only 214 men. This is at the rate of 11,500 kw per man. Putting it another way, the capacity on the system increased more than six times, the total personnel on the payroll increased by less than 25 per cent.

Required Technical Skills

The significance of this situation is not measured entirely in numbers. In order to achieve such a revolutionary change in the plant organizational structure, it has been necessary to completely revise our concepts with respect to the technical control of operations and the type of competency required. The practical operator of today's power plant represents an impressive advance in intellectual know-how as compared with the manpower of 30 years ago. He is generally aware that the rapid technological advances in his field in our expanding economy are usually "reflected in greater employment and the general elevation of his economic and social position [2]."

This steady improvement in the quality of both technical and nontechnical manpower has not been accomplished by replacing the old organization with a new team. The change has been brought about by a combination of intensified education of existing employees and greater selectivity in hiring new men. Improving the quality of the organization has been a difficult task and is not yet fully accomplished.

The newly recruited engineer does not always understand this situation as it applies to technical manpower. He soon discovers that there is a large discrepancy in the average rate of advancement in which those with the longer service frequently did not fare so well. This is true today, not only because of the steeper rate of rise in salaries in the early years of employment but also because the academic qualifications of a larger percentage of individuals hired in the past were geared to the lower technological level of the art. Thus approximately 25 per cent of those recently hired have been selected with more exacting requirements both as to academic proficiency and personal qualifications such as initiative, imagination, creative ability, and leadership.

In the case of older employees, where the response to training has been satisfactory, these individuals have progressed to key positions by reason of their greater experience supplemented with specialized training and self-education. On the other hand, there are those who have been unable to keep pace with the rapid advance of the art.

It is impossible to evaluate today's situation in terms of yesterday's conditions, and the rate of advance both technologically and salarywise cannot be measured on the basis of a linear extrapolation of past situations. Actually, recent advances have been along an exponential line. Steeper salary progressions during the first five years of employment have also been adopted by some companies. This is in keeping with the more rapid acquirement of technical skills expected today, and because of the more formalized and intensified training programs necessary to develop these at an ever-increasing rate.

Influence of Management Practice

The more plentiful supply of engineers in the prewar era resulted in a rather careless distribution of the work load as between engineering and technician assignments. The engineering content of work delegated to engineering graduates was frequently at a low level, and many jobs which could be performed adequately by technicians were included.

However, the combination of major technological advances, greatly increased size of generating systems, and the shortage of engineers, dating particularly from the Korean conflict, has made it necessary to completely over haul policies and practices regarding recruiting and job assignments for engineers.

In the face of an unprecedented demand for engineers in the fields of electronics, jet propulsion, and other specializations, the rapidly changing scene in the field of power generation has been largely overlooked by many educational institutions. Some educators in mechanical and electrical engineering appear to be thinking in terms of the situation which existed ten or fifteen years ago.

The trend in manpower utilization is in the direction of substituting quality for quantity. The following gives a recent example of the breakdown between professional engineers and technicians in the over-all power-production organization. In the three categories listed, groups A and B each contain roughly 20 per cent of the total, and a sharper line is now drawn between those who perform work principally of a staff-engineering nature, group A, and those who are more involved in the daily problems of the technical control of operations, group B.

1 *Professional—Group A, Staff Engineering and Technical Management.* Activities cover the mechanical and electrical engineering, and technical management of conventional and nuclear-power-plant operations. In the long view the individuals in this category will be screened to progress along one or the other of two somewhat divergent lines wherein the emphasis is placed upon: (*a*) Progressively increasing responsibilities in the field of application engineering, operations research, and analytical evaluations and optimization of operations problems and planning; (*b*) a gradual assumption of administrative duties and general technical management of plant operations as required of top level supervisors. Those in the first category are assigned principally to staff engineering work which is given priority over the day-to-day problems of plant operation. Those in the second category are brought closer to the daily problems of plant management and operations planning as distinct from the strictly staff engineering assignments of the first group.

2 *Professional—Group B, Technical Operations Control.* This group serves as a buffer between groups A and C, and consists of those individuals who divide their time between work of an engineering nature and responsibilities involving supervision of certain special operations. In addition to engineering graduates, there are also assigned as assistants certain individuals with two or more years of college engineering, or its equivalent, who have demonstrated exceptional performance and skill in specialized areas. Experience has indicated that this arrangement serves to establish a better balance of required skills for carrying out the assignments in this category. Activities include: (*a*) Supervision and planning of plant tests and computation and analysis of results; (*b*) supervision and programming of the work performed by the technicians (group C) in connection with the calibration and servicing of instruments and controls, work involving vital arteries of the plant cycle which requires the most careful supervision, the responsibility for which cannot be assumed entirely by technicians; (*c*) miscellaneous engineering assignments in collaboration with group A, and assistance to group A with respect to engineering details, and some work of a semi-technical nature.

3 *Technicians—Group C.* This group consists of men with a formal education of at least two years of Junior College or its equivalent who can pass the Bennett and Fry Mechanical Comprehension Test. They are responsible for the mechanical upkeep and calibration of instruments and controls under the general direction of one or more individuals in group B. They also assist in the conduct of plant tests and in charting test data, taking readings, and so forth. Those whose performance is outstanding can progress into group B as described.

The most interesting development in the efforts to recruit top-grade personnel from the universities has been the summer-training program. In the author's company, this is directed principally toward mechanical and electrical-engineering majors who have completed their junior year. The program includes seminar sessions as well as on-the-job training. In the early years of this new undertaking, students accepted these jobs largely because of the relatively good pay and such inconsequential factors as nearness of the plant to their home. However, individuals completing the program soon became aware of the fact that the work presented an outstanding challenge to competent engineers. These men on returning to their universities for their senior year, became our greatest ambassadors. Now it is apparent that there is a growing interest in the power business from the students in the top 20 per cent of their class, and selective hiring in this bracket is possible.

Creative Engineering in the Power Field

The power industry is not engaged in the mass production of tangible things. The end product is electric energy which is intangible, as is also a large part of the processes involved in its production. Although the basic responsibilities in the technical management of this process are vested in a relatively few individuals possessing very special qualifications, this is not the field for the specialist capable of inventing the transistor. What is required is a creative mind with breadth of vision and perspective regarding the functioning and interrelation of systems. Intellectual versatility with the ability not only to analyze but also to integrate and optimize many apparently unrelated factors is highly desirable. It is possible to cite many examples of the challenging engineering problems in the field of power generation.

Co-operative research with manufacturers is constantly in progress. Optimization concepts in maintenance management have led to the use of digital computers in routine planning of major equipment outages [3]. Special types of computers are also being used in the development of plant-performance-monitoring systems and in the improvement of techniques involved in the economic dispatch of generation. The examples which follow are in the less-publicized general areas just described, although many others of equal or greater importance could be given which apply to radically different phases of the business:

1 In a certain area of a large generating system about 10 years ago, the growth of high-voltage transmission-line capacity and the increased use of unswitched capacitors had brought about a high-voltage condition during light-load periods. It became necessary to operate two cross-compound turbogenerators underexcited to power factors as low as 0.95 leading. On one or two occasions, the high and low-pressure elements drifted out of step under steady-state conditions at this low level of excitation. One of the leading turbine manufacturers had become interested in promoting a more extensive use of voltage regulators of the rotating-amplifier type. Since generator stability can more readily be maintained with the much faster rate of response of this type of regulator, the manufacturer felt that it pointed the way to lower cost generators because of the related possibility of using a lower short-circuit ratio in the design, say 0.60 to 0.65, rather than the prevailing values of 0.85 to 1.0.

This immediately suggested to the utility the possibility of an entirely different application. Having in mind the out-of-step condition referred to above and the need for bucking voltage under the operating conditions described, it was decided to run tests to determine the stability of these cross-compound units when operating in the underexcited range with rotating-amplifier voltage regulators. A comprehensive series of tests with a regulator loaned by the manufacturer was conducted both in connection with electrical stability and temperature of stator end-iron packages for a wide range of underexcited operating conditions [4]. The results of the tests pointed to the feasibility of making substantial use of the main generators on the system for bucking voltage, thereby materially reducing the need for large investments in synchronous condensers. The manufacturer also obtained valuable information on which to base design improvements which would permit new machines to be operated still further into the underexcited region. This is an example of creative thinking wherein an important technological development was the by-product of apparently unrelated factors, and also of the co-operative research which is taking place continually between the utilities and major equipment manufacturers.

2 In a previous paper, it was brought out that there is

a vast difference between the subject of maintenance practices and maintenance management [5]. The former has to do with the methods of performing the work of repair or replacement, whereas maintenance management is concerned with all those factors which relate to the problem of operating a generating system with the objective of obtaining the maximum number of available hours from the entire group of units on the system at minimum over-all cost.

Among other things, the problem is intimately related to the cost of replacement power. In some instances this exceeds the entire cost of the maintenance work to be performed. The lowest cost of performing maintenance work does not necessarily result in the lowest over-all cost when system-reserve requirements, replacement power, and other cost factors are taken into consideration. Expressed in terms of fundamentals, "the efficient function of the system is greater than that of the sum of the efficiency of the parts [6]." Such applications of operations-research techniques are rapidly coming into use in the field of power production. Platt has stated that his contact with the utility industry has led him "to the tentative conclusion that power engineering bears a remarkable resemblance to operations research and far antedates it [7]."

3 The progressive advances in power technology present an ever-changing scene with respect to the type of engineering problems which must be solved. New hardware and cycle modifications mean new problems at the production level. The ability of computers to process data involved in engineering studies which could not be undertaken at reasonable cost by manual methods has opened up whole new fields. However, one company has stated that an average of 40 hr is required to prepare a job which the computer can handle in one minute. Although this is perhaps an oversimplification, it does suggest that we are faced with an entirely new situation requiring a radically different approach to problem handling and decision making.

4 One of the current interests in the power industry is that of automatic data logging. With the great pressure from computer specialists to get into this field, it is only natural that the initial jobs may be somewhat unrealistic and slightly overdone. However, the benefits resulting from the intelligent application of these innovations can be considerable.

Tremendous strides are also being made in plant-performance monitoring, but this is also an area in which the power engineer must assume at least 50 per cent of the burden of creating such applications. Automatic economic dispatch of generation is closely involved with the concept of performance monitoring. As is well known, much has been achieved, particularly with analog computers, in the continuous process of optimizing the factors of incremental generating cost and transmission-line loss, so that the lowest cost increment of generation is obtained at the load center at any instant. In this manner the specific generator on the system which should be selected for the next increment of load is continuously and automatically determined.

On the other hand, as in the case of all computer operations, the output of the computer is only as accurate as the information which is fed into it. The most difficult data to obtain accurately in this particular application are the incremental-heat-rate characteristics of each generating unit. Complete plant-heat-rate or over-all input-output tests can be conducted and will give the necessary information for the operating conditions which prevail at the time of the test. However, these conditions may change from day to day and sometimes from hour to hour so that the test data soon become obsolete. The large annual consumptions of fuel costing many millions of dollars mean that small percentage errors are reflected in sizable annual costs. Actually this whole problem involves a considerable number of rather complicated technical considerations which are beyond the scope of this paper. It is sufficient to observe here that the creation of automatic means of continuously and accurately monitoring incremental heat rates and feeding such information into the appropriate function-generator circuits of the automatic or semiautomatic system is merely another example of the complex and challenging engineering problems in which the power engineer is heavily involved.

Research and Development

The advent of computers has brought about new vistas in the field of automation, in research in the development of new thermal cycles, and in improved methods of technical decision-making and planning in the area of production management.

The economic pressure from the rising costs of labor, fuel, and other materials justify the taking of calculated risks both by manufacturers and utilities in testing and analyzing untried designs. This leads to a great amount of continuing research and development long after a plant is first placed into operation. Co-operation with the manufacturer leads to further major improvements in the basic design and layout. New system operating conditions frequently arise which demand plant performance beyond that which was conceived in the original design, and of course there is also the basic need for continually improving performance in terms of production costs.

Utilities perhaps have been lax in dramatizing these important behind-the-scenes activities, and the story all too frequently escapes the attention of engineering faculties. The popular conception appears to be that the plant is "debugged" within the first few weeks of its operation and then continues to operate without further engineering attention.

Educational and Intellectual Factors

Educators in mechanical and electrical engineering have made a wise decision in providing more fundamental scientific courses in place of engineering-laboratory and other functional instruction. Although emphasis upon the language of mathematics is also essential, there must be a better understanding of the wide difference in the basic approach required of the specialist-in-depth on the one hand and the engineer who must deal, for example, with the multiple thermodynamic systems which occur in modern power-generation cycles. A good example can be found in the field of computers. Their mathematical complexity has created a generation of specialists who have made spectacular accomplishments in developing devices with astonishing capacity and diversity.

However, in seeking markets for this equipment, experts are discovering a barrier between the sophistication of the computer and the development of practical applications for its use.

There is a formidable gap in basic knowledge between the computer specialist and the power engineer. There are many who are competent to create and design almost anything in terms of computer hardware but who are frequently at a loss as to what to do with it. This is a very good illustration of the difference between an engineering scientist and an engineer. There is a growing sense of urgency in the effort to find engineers who have the knowledge to direct this know-how into useful channels of application.

There is a profound difference in the engineering of the so-called light and heavy industries regardless of the common meeting ground which can usually be established in terms of scientific fundamentals. What is valid in scientific knowledge relating to a process does not necessarily tell the vital story in terms of its engineering application. However, it is important to emphasize that intellectual qualities and mental processes are being referred to, not practical experience. It is no more possible to apply the same type of thinking to the power plant of an automobile, an airplane, a gas turbine, a jet-propulsion engine, or a million-kilowatt thermal generating station, than it is to make a good machinist out of a watchmaker.

This greater emphasis upon mathematics and the fundamental sciences will bring us closer to the creation of the all-around engineer, supposedly qualified to perform any engineering job. There is danger, however, that this approach may develop all-around scientists rather than all-around engineers.

The acceptance of scientific knowledge and the ability to reason mathematically as the principal qualifications of an engineer are at least partly responsible for the tendency toward more and more specialization in engineering fields. Certainly a basic scientific background is necessary for the engineer, but there must also be those other intellectual qualities of perspective, ability to synthesize as well as analyze, and to integrate many factors into an engineering conclusion with proper economic justification. These are mental processes and qualities of intellect which in large degree should be regarded as prerequisites to the satisfactory development of judgment through experience. Without them it would be possible to train the individual only in a very specialized area of engineering. Such specialization inevitably leads to more and more reliance upon the team concept in order to handle engineering problems of any major significance.

This is not meant to be criticism of the splendid accomplishments which have frequently developed out of the judicious use of well-balanced scientific or engineering teams where engineers with diverse backgrounds co-operate in bringing their collectively broad and individually deep insights to bear upon a major problem. However, overspecialization sometimes forces the substitution of quantity for lack of the desired broader intellectual insight and capacity of a lesser number of individuals. In a report presented at the Fifth Annual Conference of California Group, Investment Bankers Association of America, Mace noted the increasing trend in manufacturing companies to operate with groups of specialists and stated that "this functional specialization has tended to limit the points of view of potential executives and to confine them to very narrow areas [8]." It would appear that a note of caution is in order lest we develop a new generation wherein tunnel-vision intellects predominate.

Those desiring an outstanding engineering career, particularly in the power field, should carefully consider these factors or they may continue through life as specialists unable to penetrate beyond the more superficial engineering phases of the business. It is also hoped that engineering faculties may find it possible to develop means of placing greater emphasis upon the development in the student of those intellectual qualifications which have just been described. The problems are formidable in the face of an already crowded curriculum, but certainly they deserve the most serious consideration. We must get away from the idea, expressed or implied, that an engineer is essentially a scientist with some practical experience in the design of hardware as a result of which he has acquired judgment in the execution of his assignments. This is a very dull and unrealistic concept of an engineer, but unfortunately it represents a viewpoint which is not uncommonly found in the field of education.

Conclusion

The engineering scene in the power industry has been changing rapidly, and today's problems and the outlook for further spectacular advances in the art present a tremendous challenge to the best engineering talent. Much could have been added to the few examples given in this paper as to the impact of today's pioneer developments in nuclear power, increased steam temperature and pressure, once-through boilers in the subcritical and supercritical-pressure ranges, advanced concepts in full automation of plants, combined steam and gas-turbine cycles, and so forth. These phases of the power industry embrace vast and imposing fields of engineering hardly touched upon which are absorbing the urgent attention of power engineers in the areas of design, application, and technical management.

Recent technological advances have had an effect upon the quality and organization of engineering manpower in the utilities and in types of engineering skills required for a successful career in this industry. These various developments have required a readjustment of utility-management practices in the training, utilization, and salary standards of engineers. All of these factors have impressively affected the outlook for an engineering career in the power field.

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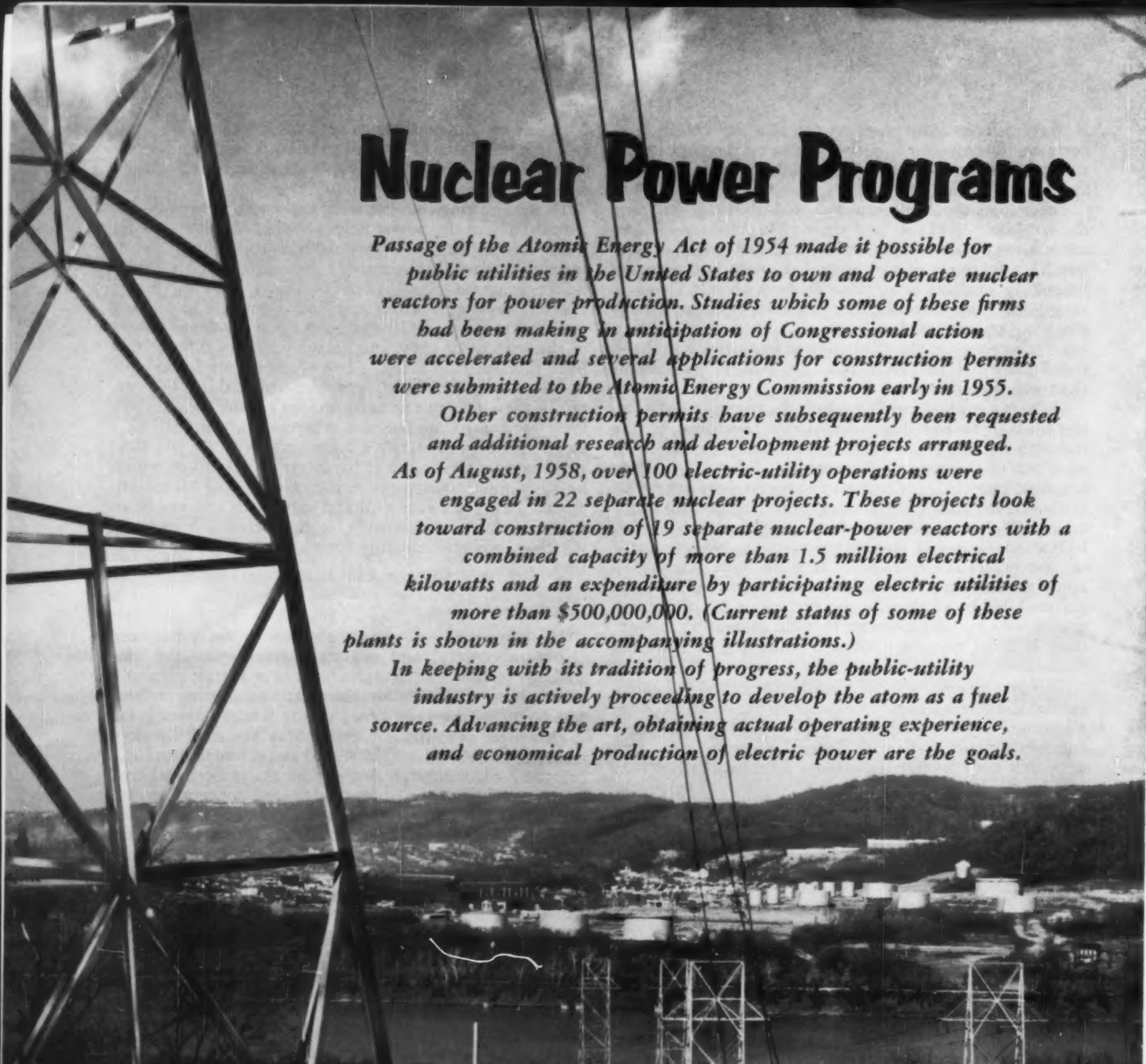
Nuclear Power Programs

Passage of the Atomic Energy Act of 1954 made it possible for public utilities in the United States to own and operate nuclear reactors for power production. Studies which some of these firms had been making in anticipation of Congressional action were accelerated and several applications for construction permits were submitted to the Atomic Energy Commission early in 1955.

Other construction permits have subsequently been requested and additional research and development projects arranged. As of August, 1958, over 100 electric-utility operations were engaged in 22 separate nuclear projects. These projects look toward construction of 19 separate nuclear-power reactors with a combined capacity of more than 1.5 million electrical kilowatts and an expenditure by participating electric utilities of more than $500,000,000. (Current status of some of these plants is shown in the accompanying illustrations.)

In keeping with its tradition of progress, the public-utility industry is actively proceeding to develop the atom as a fuel source. Advancing the art, obtaining actual operating experience, and economical production of electric power are the goals.



Shippingport, the nation's first full-scale commercial atomic power plant to become operable

# of Public Utilities in the U. S.

By **James F. Fairman**, Senior Vice-President, Consolidated Edison Company of New York, Inc., New York, N. Y.

In August, 1958, over 100 electric utilities in the United States were participating in the development of nuclear power. The projects in which these utilities were participating are described under the following five headings: Independent Industrial Program, Power Demonstration Reactor Program, AEC Reactor Development Program, Independent Research and Development Programs, and Programs Not Yet Determined. All status information is based on that available as of August, 1958.

The Independent Industrial Program includes projects for which the sponsoring organization bears the entire costs. It is not a formal program under government sponsorship, although participants are required to comply with AEC regulations.

The Power Demonstration Reactor Program was established by the Atomic Energy Act of 1954. This program was designed "to bring private resources into the development of engineering information on the performance of nuclear power reactors and to advance the time when nuclear power will become economically competitive." The AEC assists organizations that make satisfactory proposals for nuclear reactor projects under this program through waiving charges for loan of source and special nuclear materials, performing or contracting for research and development work, and in some cases financing and retaining title to all or part of the reactor system. The AEC has extended three invitations for proposals under this program, the first on January 10, 1955, the second on September 21, 1955, and the third on January 7, 1957.

The AEC Reactor Development Program was initiated in early 1954. It is the basic nuclear-reactor development program of the Atomic Energy Commission and its objective is to develop promising reactor types to the point where construction of prototype or large-scale reactors is feasible. Thus far, the scope of this program has been to carry the development of promising reactor types through the construction of an experimental reactor. With the exception of the Shippingport plant, these reactors are of relatively small heat output and in some instances provision of electric-generating capacity is not planned. These projects for the most part are financed by the Atomic Energy Commission. Electric utilities are participating with the AEC in the development and construction of two of these experimental-reactor projects, and are bearing a portion of the project costs.

Independent Research and Development Programs are those major programs of electric utilities in the field of nuclear research and development which do not include plans for development and construction of reactors at the present time. These programs are being financed by the organizations concerned.

Condensed from a paper presented at the Canadian Sectional Meeting, Montreal, Que., Canada, September 7–11, 1958, of the World Power Conference. Conference paper no. 36 B_3/10. The American Society of Mechanical Engineers is a Member of the professional-engineering-society group of the United States National Committee for the World Power Conference.

Independent Industrial Program

1 Consolidated Edison Company of New York, Inc. The Indian Point plant under construction for the Consolidated Edison Company of New York, Inc., near Peekskill, N. Y., is the largest nuclear plant presently planned in the United States, although a portion of the capacity will be furnished by an oil-fired superheater. The plant is scheduled for completion in 1960. Energy from this plant will cost about 13 mills per kwhr based on the latest estimates.

Following consideration of various proposals, the Company selected one made by The Babcock & Wilcox Company for construction of a 236,000-electrical-kw pressurized-water thorium-uranium-converter nuclear power plant. Approximately 140,000 kw of capacity was to be supplied by the reactor, while 96,000 kw was to be furnished by the oil-fired superheater. The AEC permit was issued on May 4, 1956, and site preparation and excavation work were started the latter part of that year. Because of certain design modifications, the start of major construction was deferred until the early part of 1958.

Initially, it was estimated the plant would cost $55 million. As the design developed, it was decided to increase the capacity to 275,000 kw, of which approximately 163,000 kw would be supplied by the reactor and 112,000 kw by the oil-fired superheater. Present estimates show the final cost of the plant may be in the neighborhood of $90 million. The increase in cost over the original estimates is due in part to the added capacity, in part to certain design changes based on new information, and in part to increases in costs of materials, equipment, and labor.

2 Commonwealth Edison Company—Nuclear Power Group, Inc. The Dresden Nuclear Power Station, being built in Illinois, 50 miles southwest of Chicago, adjacent to the Des Plaines and Kankakee Rivers, is a joint enterprise of Nuclear Power Group, Inc., and is the largest all-nuclear power plant scheduled in the U. S. at the present time.

The Nuclear Power Group was formed in 1953 to study nuclear-power development under the AEC industrial-study-group program. On March 31, 1955, this group made a proposal for the development and construction of a 180,000-kw dual-cycle boiling-water-reactor nuclear power plant in response to the first round of invitations under the AEC Power Demonstration Reactor Program. However, since this proposal did not call for any government assistance, the AEC subsequently decided not to consider the project as a part of the Power Demonstration Reactor Program, but rather as a project under the "Independent Industrial Program."

In July, 1955, a $45-million contract was signed with the General Electric Company for construction of the

plant, and the AEC permit was issued in May, 1956. Major construction began in 1957, and completion and service are scheduled for 1960.

Nuclear Power Group, Inc., is composed of the following companies: American Gas and Electric Service Corporation, Bechtel Corporation, Central Illinois Light Company, Commonwealth Edison Company, Illinois Power Company, Kansas City Power and Light Company, Pacific Gas and Electric Company, and Union Electric Company.

The Commonwealth Edison Company will own and operate the plant and will pay $30 million of the $45-million contract price plus over $5.5 million for administrative and site costs. The $15-million remainder of the contract cost is being paid as a research and development expense over a 5-yr period by the eight companies in the group. The General Electric Company, as prime contractor, is responsible for "design, development, and construction" of the plant. Bechtel Corporation is the engineer-constructor.

Dresden will be the nation's first large-scale boiling-water reactor. On the basis of disregarding the $15-million research contribution, it is estimated that the plant will ultimately produce energy at a cost of $^{3}/_{4}$¢ per kwhr, which is about the same as that in the Commonwealth Edison Company's newest coal-fired plants. At its full cost, however, the plant will not produce electricity as cheaply as a modern conventional station.

3 *General Electric—Pacific Gas and Electric Company.* General Electric Company and the Pacific Gas and Electric Company, designed, built, and operate a 5000-electrical-kw nuclear power plant located at GE's Vallecitos Atomic Laboratory, Alameda County, Calif., about 40 40 miles southeast of San Francisco. The General Electric Company designed, constructed, owns, and operates the reactor, and the Pacific Gas and Electric Company installed and is operating the conventional generating facilities. The AEC issued a permit in May, 1956, for the construction of this plant. Work began shortly thereafter, and customers of Pacific Gas and Electric received the first power generated from nuclear energy in a plant wholly financed by private industry on October 24, 1957.*

The reactor is of the dual-cycle boiling-water type and is being used to obtain technical data for the full-scale dual-cycle boiling-water reactor which General Electric is building for the Commonwealth Edison Company-Nuclear Power Group, Inc. The reactor cost $2.5 millon, the turbogenerator facilities $600,000.

4 *Pacific Gas and Electric Company—Humboldt Bay.* On February 18, 1958, Pacific Gas and Electric Company announced that it had completed negotiations to build a 60,000-electrical-kw advanced boiling-water nuclear power plant in the Humboldt Bay area, south of Eureka, Calif., scheduled for completion by 1962. Pacific Gas and Electric Company has contracted with Bechtel Corporation for development and construction of the plant. General Electric Company will supply the nuclear and electrical equipment.

The cost of this plant, including research and development, is estimated to be $20 million, and will be borne entirely by Pacific Gas and Electric. According to the company, this project, which will be located in a moderately high-cost fuel area, is expected to achieve competitive power costing 8 mills per kwhr with its second core, assuming present plutonium credits.

Indian Point, being built by Consolidated Edison near New York, will combine nuclear fuel and oil-fired superheat to produce 275,000 electrical kw.

Enrico Fermi will supply 100,000 kw by early 1965. Two nonprofit industrial groups are building the reactor, and Detroit Edison is building the turbine-generator.

Dresden, the largest all-nuclear plant—180,000 kw—is well ahead of schedule and expected to be in operation near Chicago 6 months ahead of contract date, December 7, 1960.

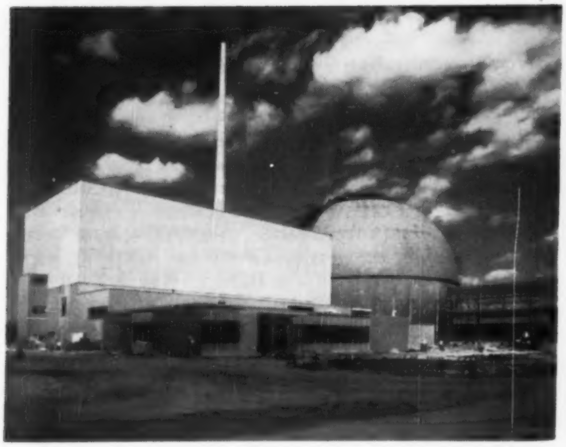
Vallecitos is a 5000-kw dual-cycle boiling-water installation near Pleasanton, Calif., which has been operating since October, 1957, to provide operational data.

Power Demonstration Reactor Program—First Round

1 *Consumers Public Power District of Nebraska.* In September, 1957, the AEC and Consumers Public Power District of Nebraska reached agreement on contract terms covering the construction of a 75,000-electrical-kw sodium-graphite nuclear power plant to be located at Hallam, Nebr. The Bechtel Corporation has been selected as architect-engineer for this project, and Atomics International, a division of North American Aviation, Inc., has technical responsibility for the nuclear-reactor facilities. Work on the conventional turbogenerator facilities was expected to begin early in 1958 and the plant is expected to be in operation, powered by conventional boiler facilities, by April, 1960. Construction of the reactor facilities is expected to start in mid-1959 with full operation the latter part of 1961.

The project will cost over $66 million, including $18 million for research and development, and $8 million postconstruction costs covering some fuel costs and extraordinary maintenance. The AEC will pay a total of $49,780,000 toward the cost of the reactor, research and development, and postconstruction costs.

2 *Power Reactor Development Company—Detroit Edison Company.* In the latter part of 1950 the Detroit Edison Company and the Dow Chemical Company made a proposal to the AEC to study the feasibility of using nuclear heat to generate electric power which was accepted in the latter part of 1952. Additional companies subsequently joined the original two in carrying out further studies, and in the latter part of 1954, following withdrawal of the Dow Chemical Company, the group adopted the name Atomic Power Development Associates. Studies conducted by this group on the fast-breeder concept resulted on March 31, 1955, in a proposal by a group of utility companies, many of whom were members of APDA, to construct a developmental fast-breeder reactor. On August 8, 1955, the AEC accepted this proposal as a basis for negotiation, and three weeks later the companies that made the proposal organized the Power Reactor Development Company, a nonprofit corporation, which would finance and own the developmental reactor. In August, 1956, the Power Reactor Development Company received a conditional construction permit, and work soon began on the 100,000-



electrical-kw Enrico Fermi Atomic Plant to be built near Monroe, Mich., about 30 miles south of Detroit on Lake Erie. Plans call for completion and initial operation by 1960. Steam from the reactor will be sold to the Detroit Edison Company to drive turbine-generators which the latter company will furnish.

The Power Reactor Development Company is comprised of the following companies: Allis-Chalmers Manufacturing Company, The Babcock & Wilcox Company, Burroughs Corporation, Central Hudson Gas & Electric Corporation, The Cincinnati Gas & Electric Company, Columbus and Southern Ohio Electric Company, Combustion Engineering, Inc., Consumers Power Company, Delaware Power & Light Company, The Detroit Edison Company, Fruehauf Trailer Company, Holley Carburetor Company, Iowa-Illinois Gas & Electric Company, Long Island Lighting Company, Philadelphia Electric Company, Potomac Electric Power Company, Rochester Gas and Electric Corporation, Southern Services, Inc. (representative of: The Southern Company, Alabama Power Company, Georgia Power Company, Gulf Power Company, Mississippi Power Company), The Toledo Edison Company, Westinghouse Electric Corporation, and Wisconsin Electric Power Company.

The project, including research and development but excluding fuel-use charges, will cost approximately \$71.6 million. The nuclear portion is estimated to cost \$37,020,000 of which over \$34,020,000 will be paid by the Power Reactor Development Company, and \$3 million by Atomic Power Development Associates, Inc. Conventional turbine-generator facilities, to be furnished by Detroit Edison, are estimated to cost \$14,061,000. Research and development costs are estimated at \$20,515,000 of which \$5 million will be paid by PRDC, \$11,065,000 by APDA, and \$4,450,000 by the AEC as its assistance under the Power Demonstration Reactor Program. The AEC will also waive fuel-use charges for nuclear fuel for a period of five years following initial operation of the plant.

3 *Yankee Atomic Electric Company.* In September, 1954, a group of twelve New England electric-utility companies formed the Yankee Atomic Electric Company to undertake the development and construction of a demonstration nuclear power plant.

This organization consists of: Boston Electric Company, Central Main Power Company, Central Vermont Public Service Corporation, Connecticut Light & Power Company, Connecticut Power Company, Hartford Electric Light Company, Public Service Company of New Hampshire, Western Massachusetts Electric Company, a subsidiary of New England Electric System (New England Power Company), subsidiaries of New England Gas & Electric Association (Cambridge Electric Light Company, New Bedford Gas & Edison Light Company), and an affiliate of Eastern Utilities Associates (Montaup Electric Company). (NOTE: Connecticut Power Company has since merged with the Hartford Electric Light Company.)

In June, 1956, the AEC signed a contract with Yankee, the first such contract it entered into under the Power Demonstration Reactor Program. The AEC announced in August, 1957, that it intended to issue a permit for construction of the 134,000-electrical-kw pressurized-water nuclear power plant which is to be built by Westinghouse Electric Corporation at Rowe, Mass. Construction has been under way since early 1958 and is proceeding on schedule toward completion in 1960.

It is estimated that the project will cost \$62 million, including \$6.5 million for research and development. Yankee will bear \$57 million of the cost and the AEC will provide \$5 million toward research and develop-

Nuclear Power Programs of Public Utilities in the U.S.

ment. In addition, the AEC will waive fuel-use charges for a period of five years.

Power Demonstration Reactor Program—Second Round

The second round of invitations under the AEC Power Demonstration Reactor Program was announced on September 21, 1955. This round specifically called for proposals for small-scale reactors. Seven proposals were received, of which four were accepted, and negotiations on these projects took place over a period of a year or more. In the summer of 1957, Congress passed a law directing the AEC to construct and own the four reactors proposed under this round, and sell steam to the proposing organization at costs not to exceed those of steam from conventional boiler facilities in the areas concerned. Participating organizations are to furnish the sites and the conventional generating facilities.

1 *City of Piqua, Ohio.* This project calls for the development and construction of a 12,500-electrical-kw organic-moderated nuclear-reactor power plant to be located near the city of Piqua, Ohio. Atomics International, a division of North American Aviation, is to construct the reactor. Present estimates are that the plant will be in operation some time in 1961. Cost of the project is estimated at $16,200,000 of which the AEC will pay $12,305,000. The reactor will feed steam into the turbine-generator facilities of an existing power plant owned by the city.

2 *Chugach Electric Association.* This project calls for the development and construction of a 10,000-electrical-kw sodium-cooled heavy-water-moderated nuclear-reactor power plant in the vicinity of Anchorage, Alaska. Nuclear Development Corporation of America is undertaking the first phase (initial development and design) of a three-phase program aimed at eventual construction of this reactor. Work has been under way for over a year and is expected to extend until mid-1960.

Cost of the project to the AEC is estimated to be $21,609,000. Chugach will make available the site and conventional generating facilities estimated at $1,900,000.

3 *Rural Cooperative Power Association, Elk River, Minn.* This project called for the development and construction of a 22,000-electrical-kw boiling-water-reactor nuclear power plant near Elk River, Minn. The AEC's portion of the estimated cost is $11,445,000. The Rural Cooperative Power Association will contribute $2,450,000. Construction by ACF Industries was to start in 1958 and be completed by 1960.

4 *Wolverine Electric Cooperative Association, Hersey, Mich.* This project called for the development and construction of a 10,000-electrical-kw aqueous homogeneous nuclear-reactor power plant at Hersey, Mich. In May, 1958, the AEC discontinued further action because of unfavorable economic aspects.

It was originally estimated that the cost of this project to the AEC would be $5,472,000. Wolverine is to furnish the site and conventional generating facilities. The company that was to build the plant announced in September, 1957, that it was withdrawing its proposal to undertake the project for $5,472,000, but was prepared to proceed on a cost basis. The company estimated the

Sodium Reactor Experiment near Los Angeles was designed, built, and operated by Atomics International for the AEC to provide data on the sodium-graphite type.

Yankee, a 134,000-kw plant at Rowe, Mass., is a $50-million pressurized-water plant on which major construction began a few months ago.

cost would now be $14,436,000. On October 3, 1957, the AEC cancelled plans to negotiate this contract with the company concerned.

Power Demonstration Reactor Program—Third Round

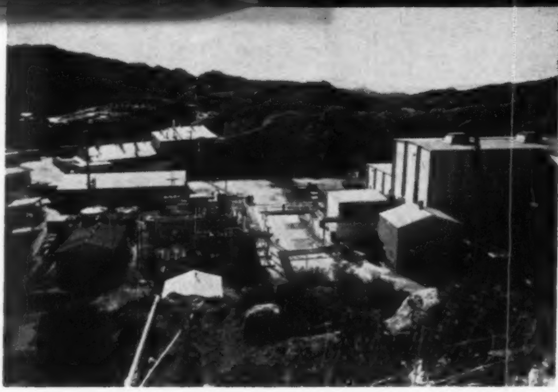
1 *East Central Nuclear Group—Florida West Coast Nuclear Group.* In May, 1956, three Florida electric-utility companies formed the Florida Nuclear Power Group which included the Florida Power and Light Company, Florida Power Corporation, and Tampa Electric Company. Following investigation of several reactor types, the Florida Nuclear Power Group on April 30, 1957, submitted a proposal to the AEC for the development and construction of a heavy-water-moderated gas-cooled reactor with 136,000-electrical-kw capacity. This was not found acceptable by the AEC, and in late 1957 Florida Power Corporation and Tampa Electric Company formed the Florida West Coast Nuclear Group which joined with the East Central Nuclear Group in submitting a proposal to develop and construct an advanced heavy-water-moderated gas-cooled enriched-uranium 50,000-electrical-kw reactor to be completed by 1963. This would serve as the prototype for a future 200,000-kw natural-uranium reactor. Estimated cost including excess operating cost during the first 5 years of operation is $50,221,000. AEC's contribution would be $9,097,000 and waiver of fuel-use and heavy-water charges for 5 years.

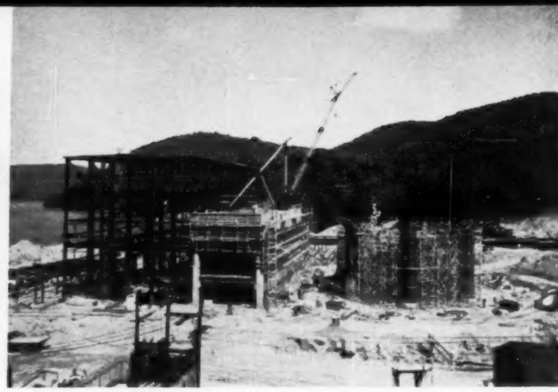
East Central Nuclear Group consists of: American Gas & Electric Service Corporation, Cleveland Electric Illuminating Company, Columbus & Southern Ohio Electric Company, Dayton Power & Light Company, Indianapolis Power & Light Company, Louisville Gas & Electric Company, Monongahela Power Company, Ohio Edison Company, Pennsylvania Power Company, Potomac Edison Company, Southern Indiana Gas & Electric Company, West Penn Power Company.

2 *Northern States Power Company—Central Utilities Atomic Power Associates.* In 1952 a group of companies, including several electric utilities, in the midwestern part of the United States formed the Foster-Wheeler Corporation-Pioneer Service and Engineering Company-Diamond Alkali Company Group to investigate the possibilities of nuclear-power development. As the outgrowth of these studies, the Northern States Power Company and several other electric utilities announced plans in February, 1957, for the development and construction of a controlled-recirculation boiling-water nuclear power plant.

This group consists of: Central Electric & Gas Company, Interstate Power Company, Iowa Power & Light Company, Iowa Southern Utilities Company, Madison Gas & Electric Company, Mississippi Valley Public Service Company, Northern States Power Company, Northwestern Public Service Company, Otter Tail Power Company, St. Joseph Light & Power Company, Wisconsin Public Service Corporation.

In August, 1957, the AEC accepted the proposal to develop and construct this nuclear power plant as a basis





for negotiation. Present plans call for the 66,000-electrical-kw plant to be completed and in operation by mid-1962. The Allis-Chalmers Manufacturing Company will construct the plant, and Pioneer Services and Engineering Company will act as architect-engineer.

The total cost is estimated at $28.8 million. Northern States Power Company will own and operate the nuclear plant and will pay the major portion of its costs. The Central Utilities Atomic Power Associates, exclusive of Northern States Power Company, will contribute $3,650,000 toward the cost of the project. The AEC was requested to furnish $5.5 million for research and development assistance and $500,000 for postconstruction assistance, as well as waiver of fuel-use charges, estimated at $1 million, over a 5-yr period.

3 Carolinas-Virginia Nuclear Power Associates, Inc. In October, 1956, the Carolina Power and Light Company, Duke Power Company, South Carolina Electric and Gas Company, and Virginia Electric and Power Company formed the Carolinas-Virginia Nuclear Power Associates, Inc., for the development of nuclear power in the area served by its member companies. The proposal made to the AEC in September, 1957, calls for completion of a heavy-water-moderated-and-cooled 17,000-electrical-kw plant by mid-1962. Westinghouse Electric Corporation will develop and furnish plant equipment, Stone and Webster Service Corporation will act as architect-engineer, and General Nuclear Engineering Corporation will act as consultant on nuclear science and engineering problems. Contract negotiations are under way. Total cost is estimated at $42,883,000, of which the AEC's portion would be $14,655,000.

4 Pennsylvania Advanced Reactor Project. In July, 1955, the Pennsylvania Power and Light Company announced that it was undertaking a project for the development of a large-scale aqueous-homogeneous nuclear power plant with the Westinghouse Electric Corporation. By fall, 1957, an intensive research program had been under way for over two years to determine the technical and economic potential of this type reactor. Pending positive results on its technical and economic feasibility, tentative plans are to construct a nuclear plant with capacity of 70,000 to 150,000 kw by the end of 1963. Research cost over $3 million by the end of 1956 and substantial additional funds will be required to complete research.

Cost—if constructed—is estimated at $108 million based on construction of a 150,000-kw plant. Of this sum, $78.5 million would be paid by the companies concerned. AEC was requested to provide $7 million for research and development in 1958 and 1959 and, upon decision to build, $18 million more for this purpose.

In the latter part of 1957, Baltimore Gas & Electric Company joined the project in connection with work planned for 1958 and 1959.

AEC Reactor Development Program

1 AEC-Duquesne Light Company-Westinghouse Electric Corporation. In mid-1953 the AEC authorized Westinghouse Electric Corporation to perform research and development for the design of a pressurized-water nuclear power plant to provide at least 60,000-electrical-kw capacity. In the fall of 1953 it was decided to open up the conventional part of the work for participation by private industry and proposals from interested parties were requested. In March, 1954, an offer from Duquesne Light Company was accepted and a contract subsequently negotiated. The Duquesne Light Company agreed to provide the site, design and construct the conventional part of the station, contribute $5 million toward the cost of the reactor, operate the entire plant, and purchase reactor steam on the basis of electric energy generated by that steam. The AEC was to pay for research and development and the cost of the reactor, with the exception of the $5 million being contributed by Duquesne.

This plant, located at Shippingport, Pa., is the first large-scale nuclear power plant in the world designed primarily for the production of electric power. Of the pressurized-water type, it has benefited by experience gained through construction and operation of the propulsion reactor for the world's first nuclear-powered submarine.

The plant was completed in late 1957 and on December 23 full capacity of 60,000 electrical kw was generated and fed into the Duquesne Light Company lines. Total cost was over $122,000,000. Duquesne's contribution was $23,300,000, the AEC's $98,400,000; and Westinghouse contributed $500,000 toward the cost of the reactor.

2 AEC-North American Aviation-Southern California Edison Company. In early 1954, the North American Aviation Company, which had been conducting investigations of sodium-graphite reactors for the AEC, agreed to contribute $2.5 million of the estimated $10-million cost of the development, construction, and operation of a graphite-moderated sodium-cooled reactor experiment during 1954–1958.

Initial plans did not call for installing a turbine-generator with the reactor experiment, but this was added in 1956 when the AEC accepted Southern California Edison Company's proposal. Electricity was generated at this plant for the first time in the Summer of 1957.

Located in Santa Susana, Calif., about 30 miles north of Los Angeles, the plant has a generating capacity of 6500 electrical kw. Cost has been estimated to be $18.1 million, of which the AEC paid $13,850,000, North American Aviation $2,850,000, and Southern California Edison Company $1.4 million.

Nuclear Power Programs of Public Utilities in the U. S.

Independent Research and Development Programs

1 *Southwest Atomic Energy Associates.* In December, 1956, Middle South Utilities, Inc., announced that it was considering a prototype nuclear-power reactor for use in its system area. Following investigations and discussions with neighboring utilities, it was decided to form a group to carry out a research and development program aimed at practical use of atomic energy as a supplemental fuel for the future electrical needs of the states of Arkansas, Louisiana, Mississippi, Kansas, Missouri, and Oklahoma. A contract was signed with Atomics International in January, 1958, for a 4-yr $5.3 million research and development program on an advanced epithermal reactor that would use a thorium-U-233 fuel cycle. On completion, decision will be reached as to whether a pilot plant or a full-scale plant should be built.

The following companies comprise the group: Arkansas-Missouri Power Company, Arkansas Power & Light Company, Central Louisiana Electric Company, Inc., The Empire District Electric Company, Gulf States Utilities Company, Kansas Gas & Electric Company, Kansas Power & Light Company, Louisiana Power & Light Company, Mississippi Power & Light Company, Missouri Public Service Company, New Orleans Public Service, Inc., Oklahoma Gas & Electric Company, Public Service Company of Oklahoma, Southwestern Gas & Electric Company, Western Light & Telephone Company.

2 *Texas Atomic Energy Research Foundation.* In April, 1957, a group of Texas electric-utility companies announced that they had formed the Texas Atomic Energy Research Foundation to engage in research in the atomic-energy field as applied to the generation of electric power.

Members of this foundation include the following companies: Central Power & Light Company, Community Public Service Company, Dallas Power & Light, El Paso Electric Company, Gulf States Utilities Company, Houston Lighting & Power Company, Southwestern Gas & Electric Company, Southwestern Public Service Company, Texas Electric Service Company, Texas Power & Light Company, West Texas Utilities Company.

On May 10, it was announced that the Texas Atomic Energy Research Foundation had signed a contract with General Atomic Division of General Dynamics Corporation for a 4-yr $10-million jointly sponsored research program in the field of controlled thermonuclear reactions. The research is to be carried out at General Atomics' John Jay Hopkins Laboratory for Pure and Applied Science located at the northern edge of San Diego. Research is currently under way.

Economic Aspects of

In speaking of the economic aspects of nuclear power, it is clear from fairly simple cost estimates that electricity produced from nuclear fuel in the present state of the technology costs more than electricity produced from conventional fuels in the United States.

The high cost of nuclear power as this is being written stems in part from the very novelty of this fuel source. There are still broad areas of doubt regarding such important matters as to how long a fuel element may be operated in a reactor core, how many of the safety precautions being designed into reactor plants are really necessary, whether a used fuel element will eventually represent a credit or a debit toward plant-operation cost.

One may very well ask why United States utility companies, investor-owned and state-regulated, are moving ahead at all in this shadowy field of the atom. The answer is quite simple. Managements of these companies have decided, individually and independently, that development of nuclear fuel is in the economic interests of their company's investors, customers, and employees.

In 1956, electric utilities paid $1,236,000,000 for fuel used to generate electricity. Even a relatively small saving percentagewise in fuel costs will result in substantial annual savings, other things being equal. Unlike many of the world's industrial nations, the United States is blessed with abundant supplies of relatively low-cost fossil fuels, adequate to meet its needs for years to come. However, presently known reserves of nuclear fuels, with energy content estimated to exceed that of the world's fossil fuels by more than 20 times, provide a vast expansion of the world's energy resources.

There are several programs under way to reduce the costs of fuels as they are reflected in the costs of electric-utility systems. Among these programs are: mine mechanization, pipeline transmission of both liquid and solid fuel, improvements in electric-transmission techniques which make mouth-of-mine generation practical in many instances. The over-all economic view, assuming discovery of sufficient reserves to replace consumption indicates that future prices may not be substantially higher than present prices, in terms of constant dollars.

At the generating stations there is a pattern of continuing improvement in efficiency and progressively lower operating costs. Introduction of the turbine in place of the steam engine, the successively higher steam pressures and temperatures made possible by metallurgical advances, and now the reheat, re-reheat, and supercritical boilers have carried this continuous improvement into our own day.

Each of these improvements, however, has carried a higher price tag in terms of research, development, and application than its predecessors; and each has shaved a progressively smaller bit from the cost of producing a kilowatt-hour. The main attraction of nuclear fuel to the cost-minded utility executive is to be found in this economic history of the industry. The nucleus of the fissionable atom represents a whole new fuel pattern. While cost in a central-station application appears high compared with conventional fuel prices at the moment, success in lowering this cost seems assured. And cost should fall rapidly in a comparatively few years if the industry's previous experience with innovations is to be repeated.

The magnitude of the nuclear-fuel problem has caused the various electric-utility operations in the United States to reconsider one part of their business philosophy. Traditionally, the individual companies do not do research and development work of any real magnitude. This has mostly been accomplished in laboratories owned

3 Rocky Mountain—Pacific Nuclear Research Group. In late 1954, a group of electric-utility companies and industrial and engineering companies formed the Rocky Mountain Nuclear Power Group with a full-time staff actively engaged in various investigations of nuclear power over a $3^1/_2$-yr period.

As an outgrowth of these investigations, eight investor-owned electric utility companies in the Rocky Mountain and Pacific states joined General Atomic Division of General Dynamics Corporation in June, 1958, in a major research program.

The organization is comprised of the following companies: Arizona Public Service Company, California Electric Power Company, Pacific Power & Light Company, Portland General Electric Company, Public Service Company of Colorado, Public Service Company of New Mexico, Utah Power & Light Company, and Washington Water Power Company.

The group will provide over $500,000 during the next two years to further General Atomic's multimillion-dollar nuclear-research effort. Major emphasis will be placed on the development of gas-cooled reactors. The 2-yr program will also include intensification of work in the field of direct conversion of heat into energy.

Programs Not Yet Determined

1 New England Electric System. In December, 1956, the New England Electric System announced it was planning to construct a nuclear power plant on its system by 1964. It has been estimated that a plant, tentatively planned to have a capacity of about 200,000 electrical kw, will cost in the order of $50 million. Type reactor and location have not been selected. The New England Power Company, a subsidiary of the New England Electric System, is also participating in the Yankee Atomic Electric Company project.

2 Pacific Gas and Electric Company. In February, 1957, the Pacific Gas and Electric Company announced that either alone or in partnership with other California investor-owned utilities it was planning to submit a proposal to the AEC for a 200,000-electrical-kw plant which will be built if the cost goal can be reached for this unit.

3 General Public Utilities Corporation. This Corporation, which has several subsidiaries in the United States and one in the Philippines, investigated the feasibility of installing a 60,000-kw plant on its Manila system which has high fuel costs in comparison to such costs in the U. S. However, it was decided the project was not presently feasible. Another investigation to be concluded in early 1959 will explore in detail the feasibility of adding a 10,000-electrical-kw reactor at its Saxton, Pa., power station for use with existing steam turbogenerators.

Nuclear Power Developments

and operated by equipment manufacturers. Improving their products and developing new items to meet the requirements of their customers, the manufacturers have brought forth the bulk of the equipment which has aided the utility executive in lowering costs.

The cost of this research and development work is reflected in the price tag on the equipment purchased by the utilities. Since the equipment results in either service improvements or outright cost reduction, there is no difficulty in finding investors who will finance its purchase and in effect rent it out to the utility company's customers. Eventually, of course, the equipment is worn out in serving the company's customers. At that time, through the operation of some appropriate depreciation principle, the customers will have paid off the original cost including the associated research and development expense.

From the economist's point of view, this method of financing progress approaches the ideal. It puts the financial resources of the customers, the largest group to benefit from progress, squarely behind the successful laboratory. As practiced in the United States, the method adds variety of approach to the research program and adds the spur of economic advantage to the lure of progress itself. The system rewards successful research, pays for the occasional dream that does not work but will not support any stubborn error of judgment that persists over an appreciable length of time.

There must be some hitherto-unexplained law of economics which puts research and development costs in an inverse geometric relation to the size of the object being researched and developed. The atom, small as it is, is a very expensive item with which to deal. The first cost of a reactor plant includes an exceptionally high percentage of research and development expenses which the national economy must pay in some way if the plant is to become a reality.

These large costs are the reason why, in the United States, we find separate utility companies banding together in the various associations previously discussed in order to explore the atom. Independent firms allied with other companies only on an informal, almost social basis, have entered contractual relationships with each other in order to contend with research and development programs so large and expensive that only a few electric utility companies in the nation are large enough to handle one by themselves. Thanks to the multiplicity of these groups, the approach to economic nuclear power has variety. Thanks to the experience of these companies in handling previous innovations, the reactor program appears eminently practical. Thanks to the method of financing being employed, the cost is spread over such a large geographic area that it is practically negligible on a per-capita basis.

The industry recognized the fact some years ago that paper studies would remain only paper studies unless some actual plants were built. Government price lists for nuclear fuel, for example, reflect at least in part the workings of national policy and are undoubtedly influenced to some degree by the nation's military program. The true cost of nuclear fuel cannot be ascertained until a mining and processing industry can be supported by a purely civilian demand, and the forces of competition can be put to work in this area of the nuclear fuel cycle. The same can be said of the fuel-reprocessing work, the supply of reactor hardware, and many other important elements in the approach to economic nuclear power.

Operating reactors will produce economic pictures which may or may not coincide with the paper predictions. There is only one way to find out.

GAS TURBINE PROGRESS

Some of the most significant material from the 12 papers which constitute the 1958 Gas-Turbine Progress Report is here. The report will be presented at the 1958 ASME Annual Meeting and bound copies of the complete report, only, will be available from the ASME Publication Sales Department, 29 West 39th St., New York 18, N. Y., at $5 per copy to nonmembers, $4 to members.

Material Selected
By R. Tom Sawyer,
Fellow, ASME,
Consultant,
Ho-Ho-Kus, N. J.

The authors and titles of the original papers are: A. W. Herbenar and G. R. Heckman, "Materials;" Jack B. Esgar, "Turbine Cooling;" A. D. Foster, "Fuels;" P. F. Martinuzzi, "Cycle Components;" A. L. London, "Compound Piston-and-Turbine Engines;" Otis E. Lancaster, "Aviation;" Otis E. Lancaster, and Carlton J. Bates, "Rockets and Missiles;" Frank L. Schwartz, "Automotive;" P. R. Broadley, W. M. Meyer, D. S. Neuhart, E. L. Barlow, R. C. Bond, D. S. D. Williams, and B. W. C. Cooke, "Railroad;" John W. Sawyer and Harry M. Simpson, "Marine;" B. G. A. Skrotzki, "Industrial and Stationary;" Richard P. Godwin and Edward S. Dennison, "Nuclear Power."

The Report will be published in full with discussion in the *Journal of Engineering for Power, Transactions ASME.*

The six years that have passed since the first progress report have brought the gas turbine to the forefront much sooner than many expected. Today, gas-turbine power is being used in practically every type of application suitable to prime movers. In many areas it is just being introduced, while in other fields it is well entrenched.

Not long ago the gas-turbine industry was seeking recognition and establishment. That era has come and gone. Now the question is: "How should we use the gas turbine?" rather than "should we use the gas turbine?" Today the gas turbine is finding its place steadily in more fields of application than is possible for any other two prime movers combined.

Materials

The future material needs for stationary gas turbines will be greatly influenced by the long-time performance and service records of units now in operation coupled with the availability of reliable design data and processing data on newly developed alloys. Future gas turbine materials will, in addition, depend upon the technological advances in gas-turbine metallurgy that can be effectively utilized in conjunction with progress made in gas-turbine engineering and design.

New developments in the highly alloyed austentic materials and superalloys, especially in the refractory metals, may be anticipated because of technological advances in melting and casting techniques. Greater emphasis will be placed on the heat treatment of such alloys to insure optimum high-temperature strength with good rupture ductility and long-time structural stability.

The development of cermets, ceramic coatings, and refractory metal coatings has reached a stage where application in short-life aircraft gas turbines is feasible. However, their brittleness and limited stability over long periods of operation render them unsuitable for stationary gas turbines at the present time.

Turbine Cooling

Increasing the turbine-inlet temperature of a gas-turbine engine results in very significant increases in the power output of the engine. A performance comparison of turboprop and afterburning and nonafterburning turbojet engines is shown in Fig. 1 for a range of turbine-inlet temperatures. In order to compare all engines on the same basis, the shaft power of the turboprop engine was converted to thrust by assuming that the propeller thrust was added to that of the jet. Since the comparison is on a relative rather than an absolute basis and is for a constant flight velocity, the results shown could also be interpreted as being based on specific power since power is a product of thrust and velocity. The flight Mach number of 0.9 used for the comparison is a compromise value that could be feasible for both turbojet and turboprop engines. The performance shown is relative to that of a nonafterburning turbojet engine with a 1540-F turbine-inlet temperature. All engines were assumed to

have a compressor pressure ratio of 12 and turbine adiabatic efficiencies of 0.85. Afterburning temperature was assumed to be 3000 F. From Fig. 1 it can be seen that thrust of turboprop and nonafterburning turbojet engines can be increased greatly by increasing turbine-inlet temperature.

The extent to which turbine cooling will be used in gas-turbine engines is still unknown. It is clear that for certain applications it would be desirable in order to permit increased turbine-inlet temperature, while for some other applications there is no need to operate the engines at higher temperatures. For those cases where it would be desirable to cool the turbines, many cooling methods are possible and much research information is available. It is up to the engine designer to select the most suitable cooling method for his engine type and the one that uses fabrication procedures consistent with his ideas on sound construction principles. For example, Pomatrada has a turbine operating on 2200 F which has liquid cooling of the blades and is apparently operating very satisfactorily. This is not yet ready for the commercial market, but it is an excellent research tool. The next six years should show a marked advance in turbine cooling and possibly turbine-inlet temperatures up to 2000 F.

Fuels

In 1952, difficulties imposed by the combustion of such fuels as residual oils and coal were restricting the widespread application of the stationary gas turbine. Developmental work was needed if the gas turbine was to find commercial service irrespective of the type of fuel. Development work has been done on gaseous, liquid, and solid fuels.

The accomplishments with gaseous fuels have been outstanding. Enviable long-term service has been registered by a great number of units. There has also been a considerable increase in the number of applications involved, notably at integral parts of various industrial processes. Experience in these areas substantiates the fact that the gaseous-fuel-fired gas turbine is indeed a successful prime mover.

Two major advances have been made with liquid fuels. Crude-oil-fired turbines have been introduced in oil-pipeline-pumping installations. The gas turbine has also demonstrated ability to burn residual fuels successfully under commercial conditions.

The liquid fuels that have been used include distillate, crude, and residual oils, and, to a lesser extent, creosote pitch. Fuel from oil shale awaits economically feasible production for its application. No use has been reported.

The problems associated with residual-fuel-ash corrosion and deposition are by no means completely solved, and merit special attention. In some instances, corrosion is more significant, in others deposition, and in still others, both are problems. To generalize, over the current range of practical turbine-inlet temperatures, corrosion may be appreciable at temperatures of 1150 to 1200 F, and becomes more severe with further temperature increase. Residual-fuel-ash deposition, on the other hand, can be experienced throughout the entire range of inlet temperatures, and normally increases with both temperature and pressure.

In spite of the difficulty of correlating results, because of material and testing variations, both corrosion and deposition are generally attributed to a molten or par-

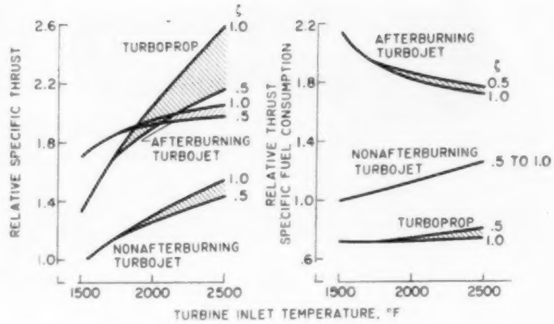


Fig. 1 Effect of turbine-inlet temperature on relative specific thrust and relative thrust specific fuel consumption. Flight Mach number, 0.9; altitude, 40,000 ft. (Effects of air cooling included.)

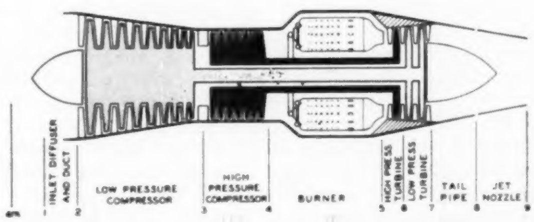


Fig. 2 Twin-spool turbojet engine

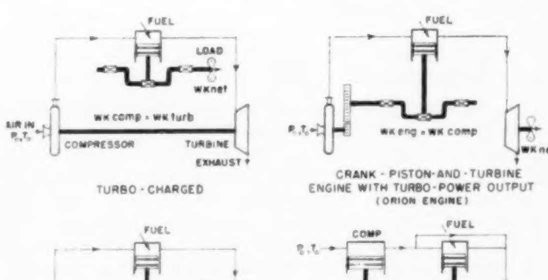
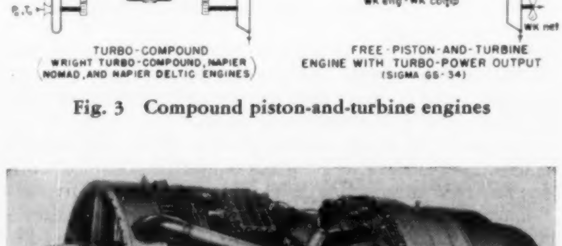


Fig. 3 Compound piston-and-turbine engines

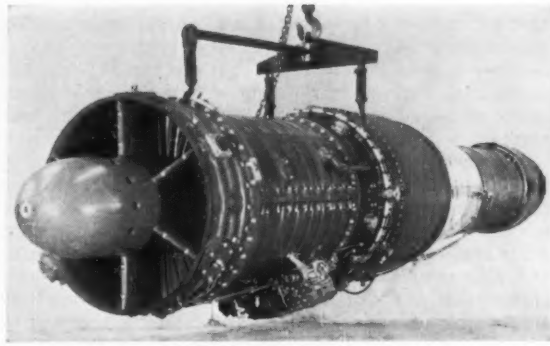


Courtesy of Rolls Royce Ltd.

Fig. 4 The Rolls Royce Avon

Fig. 5 The SNECMA ATAR-8

Fig. 6 General Motors T-56-A



Courtesy of Ste National d'Etude et de Construction de Moteurs d'Aviation

tially molten ash, and the prime offenders are considered to be the combinations of sodium, vanadium, and sulfur that occur in most residual fuels.

The main problems associated with the use of solid fuels are erosion, deposition, and corrosion resulting from the ash products, any one of which may predominate depending upon the fuel and turbine in question. There are a number of approaches available for developing a solid-fuel-fired gas turbine, the main one being the choice of cycle. Each of the three cycles that have been tested—the open, the exhaust-heated, and the closed—possesses its own distinct advantages. In addition, the possibility of gasifying coal has been studied.

Solid-fuel-fired gas turbines remain primarily in the development stage, and the coal-burning gas turbine apparently occupies about the same status that was held by the residual-oil-burning turbine at the time of the last report.

Cycle Components

The developments in gas turbines since 1952 have pointed steadily in the direction of greater simplicity. This is particularly true in the arrangement of components in the cycle. Reheat, intercooling, and even recuperation tend to be used less than before, and only where their adoption is well justified. Experience has proved that complicated cycles, which show remarkable advantages on paper, do not work as well in practice. Sometimes components are unreliable; sometimes unexpected losses nullify the advantages. The more complex cycles seem also to take much longer before their development is complete.

None of the existing gas turbines is as good as the sum of the best available components would be. If a gas turbine could be built embodying the best existing components, and if the matching of these components and the mechanical design were as good as in the best existing machine, considerable progress would be obtained without any new component development.

Currently, successful commercial gas turbines seem to follow a set pattern. An axial compressor is followed by either a single-shaft or split-shaft axial turbine with the simplest bearing arrangement, and the pressure ratio is chosen so that the use of a moderately effective heat exchanger is optional. Consequently the cycle-pressure ratio is a compromise between the high values preferable in the nonrecuperative types and the low values required for a good utilization of the heat exchanger. Even when provisions are made for an optional heat exchanger, the percentage of machines sold with them is small. This general pattern is followed by most of the successful medium and large industrial gas turbines, among which are General Electric, Westinghouse, Ruston and Hornsby, and the smaller and medium Brown Boveri models. The U. S. models generally use multiple symmetrical can combustion chambers, while the European types use single combustion chambers.

The tendency toward higher pressure ratios in jet engines, mentioned in the earlier report, was confirmed in successive years. It is very difficult to obtain high pressure ratios (over 7 to 1) in a single axial compressor. Owing to the great difference in density between the low-pressure air at the inlet and the high-pressure air at the exit, the blades of the first stages are too long, and those of the last stage too short. The twin-spool engine, Fig. 2, is the answer to this problem.

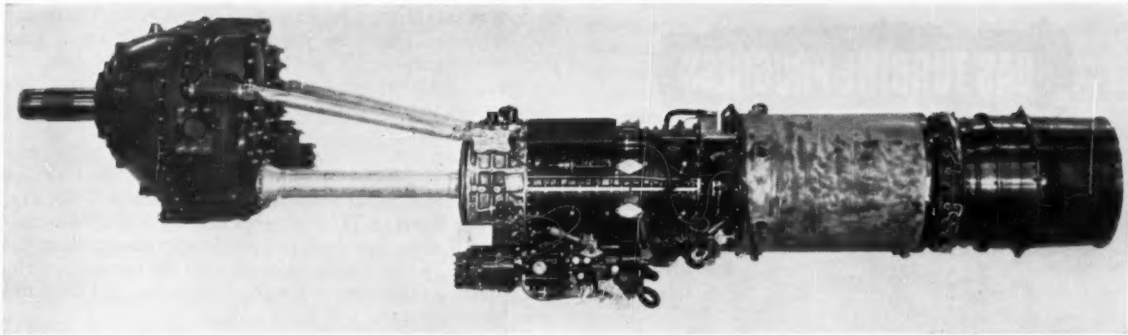
Many modern jets, such as the Pratt & Whitney J-57 and J-75, their civilian versions, and the Bristol Olympus, and the turboprops such as the Rolls Royce Tyne are of the twin-spool type.

There are several additional types of heat exchangers: The rotary-disk type, the rotary-wheel type, and a reciprocating type as well as the stationary-plate type. The smallest gas turbine is the 7-kw Turbo-Mite, and there are many unusual designs of units. The differential gear has potential in various types of gas turbines for improving acceleration of the unit, particularly when attached to a vehicle.

Compound Piston-and-Turbine Engines

The hybrid fruits of the marriage of the piston-cylinder reciprocating engine with the high-speed turbine have assumed a variety of forms. The most important ones are described schematically in Fig. 6, where the salient shaft-work features of each member of the family are specified.

The first and oldest member is the *turbocharged engine* which has already achieved technical success and wide commercial acceptance. Turbocharged aircraft engines of the spark-ignition type and 4-stroke-cycle diesels have been commercially accepted for 20 years. Today the turbocharged diesel is the standard engine for marine, tractor, and heavy-duty-truck applications. One of the really new features in this engine development is the advent of centrifugal-compressor and turbine components of high enough efficiency so that 2-stroke as well as 4-stroke diesels can now be successfully turbocharged. This was previously impossible because of the higher scavenge-air requirement, the associated lower turbine-inlet temperature, and finally the necessity of having a turbine-inlet pressure always of the order of 10 per cent



Courtesy of Allison Division, General Motors

lower than the supercharger discharger. Under these circumstances, shaft output of the turbine is sufficient to drive the compressor only when both turbine and compressor efficiencies are quite high.

The *turbo-compound engine* is characterized by the Wright spark-ignition engine which powers the DC-7 and Constellation airliners. The Napier Nomad and Napier Deltic are compression-ignition engines of this class. All the mechanical power production from the piston-engine and turbine components and the power requirements of the compressor and the load tie into the crankshaft.

The *crank-piston-and-turbine engine* with turbopower output is characterized by the recently concluded Orion engine development. Here all the piston-engine output is absorbed by the centrifugal compressor after transmission by the crankshaft and gearing. The net output comes solely from the free-power turbine.

The *free-piston-and-turbine engine* with turbopower output is characterized by the French SIGMA Model GS-34 Unit as well as several automotive-type engines under development in this country. From a thermodynamic point of view, this engine is identical to the previous member of the family as all the piston-engine output is absorbed in a compressor, of the reciprocating-piston type, and the net shaft output to the load is derived only from the power turbines. However, with a piston compressor instead of a centrifugal (or axial) type there is no need for a crank to convert reciprocating work to rotary.

It can be stated in summary that a remarkably substantial and diversified effort has gone into the cross-breeding of the piston engine with the turbine engine, Fig. 3. The prime objective is the preservation of the best features of each—the high thermal efficiency of the piston engine, and the power-compactness and torque-speed characteristics of the turbine engine. This has been achieved with both technical and commercial success in three of the four hybrids shown in Fig. 3.

Possibly more members of the family will be created in the future. With considerable certainty we can anticipate accelerated evolutionary progress now that the revolutionary changes have been accomplished, especially in view of increasing fuel costs and the pressing need to reduce or hold the line on capital costs by attaining improved power compactness and reduced specific weight.

Aviation

The nature of the development in aviation gas turbines during recent years has been essentially different from that reported in 1952. Then the engines were new and revolutionary and represented a new type which was destined to completely change the thinking in the aviation industry. This light gas-turbine power plant permitted flight speeds that were previously unattainable.

The magnitude of the results of many refinements and improvements can be appreciated best from a few specific examples. The equivalent shaft horsepower of the Rolls Royce Dart turboprop, for example, has been improved step by step from 1125 in 1948 to 2655 with corresponding decreases in specific fuel consumption from 0.830 lb per hr eshp to 0.640. These improvements resulted from increased air flow and higher compression ratios without sacrificing component efficiencies. In fact, these were improved. Although weight increased about 250 lb, the specific weight without a propeller was nevertheless reduced from 0.890 to 0.473 lb per eshp.

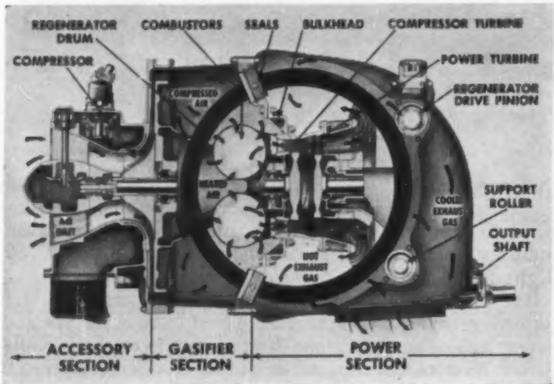
Improvements in the small-gas-turbine class, where development of efficient engines is most difficult, are illustrated by the Boeing T-50 whose sfc dropped from 1.6 to 0.75 in the five years from 1952 to 1957. Meanwhile the compression ratio went from 2.7 to 6.6, compressor efficiency from 0.69 to 0.78, and turbine efficiency from 0.67 to 0.855. While weight increased from 220 to 320 lb, eshp exactly doubled, going from 120 to 240, and specific weight decreased from 1.8 to 1.33.

In turbojet area, examples of radical improvement are not as common, for they have led the turboprops in development, and many refinements were made during the first period, as was illustrated by the J-33, J-35, J-47, and Nene. Yet the newer engine, which had had the advantages of this earlier experience, also responded to engineering refinements as is illustrated by the Avon, Fig. 4, which initially produced 6500 lb of static thrust, and has been stepped up in successive versions to 10,000 lb, while sfc dropped from 0.9 to 0.84.

The French Atar, Fig. 5, through a combination of little modifications on the engine, now has the lightest weight of any nonexpendible engine in its size. During the eight years from the first tests in 1948, thrust increased from 3750 to 9680 lb, specific weight was reduced from 0.48 to 0.25, and sfc was reduced 20 per cent.

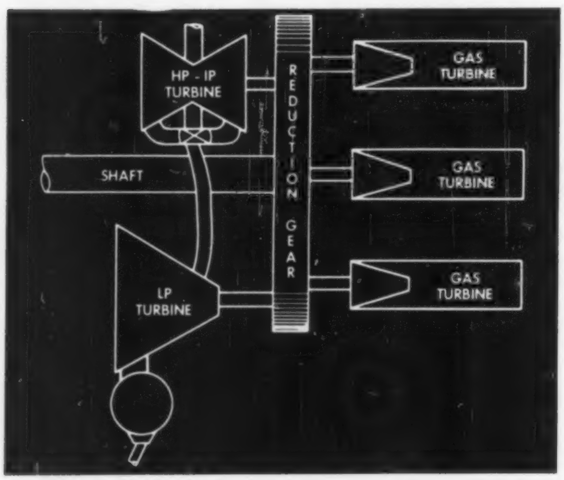
Even in their period of early development, gas turbines were given military application. All new military combat planes employ them in some form or another, mainly turbojets. Instead of the high subsonic speeds produced by the early jet fighters mentioned in the first report, the new aircraft like the Star-fighter, the P.1B, and the Hustler are obtaining flight speeds much higher than sonic velocity. One has maximum flight velocity of Mach 2.5. A few years ago this would have seemed ab-

Fig. 7 General Motors G. T. 304 turbine arrangement with rotary heat exchanger



Courtesy of U. S. Navy

Fig. 8 Gas and steam turbines combined to form a propulsion plant



surd, but now Mach 5 is considered an intermediate speed by some.

Gas turbines are not only dominating the military field, but are having their impact on commercial aviation. By 1952, the British had established the first jet transport service with the Comet. Now turbojets include the large planes like the Boeing 707, the Douglas DC-8, and the Russian TU-104; the intermediate-size planes like the French Caravelle and the Convair 880; and the small ones like the Lockheed Jet Star, which carries only 10 passengers while the largest mentioned carries 144.

Turboprop planes have also entered the transport field. Again the British were first when British European Airways began operation from London to Cyprus on April 19, 1953, with Viscounts powered by Rolls Royce Darts. The first regular commercial turboprop air route in the U. S. was established by Capital Airlines with Viscount and improved Darts on June 26, 1955. Within a year they were operating 20 of these planes on eight different airlines. Another version of the same plane was put into commercial use in Canada. To date, over 327 Viscounts have been sold.

Following the Viscounts in the commercial turboprop field were the Bristol Britannia powered by the Proteus, the Lockheed Electra propelled by the Allison T-56, Fig. 6, and the Russian TU-114 propelled by NK-12N turboprop. All three are designed for longer routes than the Viscounts. Others soon to come into the picture are the Vanguard, a replacement for the Viscounts, and the Convair Metropolitan.

While most of the airlines agree that the power plants of the future will be of the gas-turbine type, pure jet or turboprop has yet to be decided, and will probably depend on the type of service. Of the 936 airplanes on order, in the list given by *Interavia*, September, 1956, 344 were propelled by turboprops and 279 by turbojets. Thus about two thirds of the planes will employ gas turbines, over half of which are turboprops.

During this period gas turbines broke into a new field—power plants for helicopters. Driggs and Lancaster stated in 1952 that the "free-turbine" turboprop is the "only" logical engine for helicopters. This was based on the idea that several gear ratios were required for optimum helicopter use, and the degree of freedom of a free turbine is equivalent to a continuum of gear ratios. Evidently many other people agreed, for today a number of engines are being developed especially for helicopter.

Another new area of encroachment of the gas-turbine engines on the aviation industry was in the field of light airplanes. A Cessna L-19B is now propelled by the Boeing T-50. No doubt further important advances will be noted in the next progress report.

The production of aviation gas turbines has grown until they are made in hundreds and thousands. There were over 36,000 J-47's alone. When the unit cost of these engines is considered, the magnitude of the industry becomes apparent.

The total employment in the United States in connection with the design, testing, and production of these engines was over 120,000 in 1957, more than for any other year except 1953.

Rockets and Missiles

The rocket turbine driven by rocket-exhaust gases was rarely mentioned 25 years ago, but since then it has grown to be of great importance, especially in the missile field. The forerunners of these turbines were probably the gas turbines employed to drive torpedoes. Although practical liquid rockets were claimed to be operated as early as 1895, the first authenticated shot of a liquid-fueled rocket was by Robert H. Goddard in 1926 in Auburn, Mass.

In modern rockets, such as Vanguard, the turbines supply auxiliary power in addition to pumping the fuel. For other military applications, special units have been developed for auxiliary-power sources. They drive coolant pumps, hydraulic pumps for the movement of controls and various other purposes, and small generators to provide electrical power for guidance and control activation.

They exist in sizes from 2 to 20 in. in diam and with 1 to 15,000 hp. Hydrogen peroxide is the most popular propellant for the gas generator, although other conventional rocket fuels are used. In all cases, the tem-

peratures are held down by the mixing ratios or diluents. Many of the complete turbine wheels are machined from a single solid forging. The blades are short with chords about equal to their length. Many are designed to operate for durations of only 1 to 5 min, with a total life of 1 to 50 hr. When space ships arrive, the gas-turbine horsepower should multiply many times in size.

Automotive

Progress in the application of the gas turbine to vehicle propulsion has continued during the past six years at a steady but not rapid rate. Production models have yet to appear, but may be available within a decade, and many experimental models have been built. Those under development are largely in the 200 to 250-hp size, running at 25,000 to 55,000 rpm Special effort has been devoted to improving fuel consumption by adding heat exchangers to the originally proposed simple-cycle gas turbines. A great deal of the effort has been devoted to designing either rotary heat exchangers with attendant seal problems, or stationary heat exchangers with problems of manifolding, Fig. 7.

The competitive position of the gas turbine for automobiles depends largely upon the construction of a heat exchanger. A high percentage of operation at part load requires good part-load fuel consumption, which is most easily obtained by adding a heat exchanger of high effectiveness—80 per cent or better. Rotary heat exchangers are capable of this in relatively small sizes. This is accomplished by using passages of very low hydraulic radius, thereby increasing the film coefficients and surface area exposed to gases. To maintain pressure drop at acceptable limits, the length of matrix passages must be kept short. The major problem with rotary heat exchangers has been the development of seals which have low leakage losses and long life. Stationary heat exchangers of similar size and the same effectiveness can be manufactured if the same hydraulic radius is used. Such small passages, however, make the header through which gases enter and leave difficult to manufacture so that one is confronted with developing a header or a rotary seal. Because the gases pass through the passages of a rotary heat exchanger, alternately throughout the revolution of the exchanger, the exchanger is more or less self-cleaning. In the stationary heat exchanger, gases pass in steady flow in a given direction and when small passages are used there has been much fear that dirt will clog the passages; although there is insufficient experience to prove or disprove this, progress is being made in both rotary seals and manifolds. One organization reports that seals have been developed which will have a longer life than other parts of the gas turbine. Bowden of C. A. Parsons has a construction method for small hydraulic-radius stationary heat exchangers made entirely of stampings and furnace-brazed.

If the automobile companies choose to produce a gas-turbine-power automobile, a production-model car designed especially for a gas turbine could be produced by 1965. It is likely to have a 200-hp gas turbine of 4:1 pressure ratio, a maximum inlet-gas temperature of 1600 F, a single-stage centrifugal compressor of better than 80 per cent efficiency, a rotary or stationary heat exchanger of 85 to 90 per cent effectiveness, a 2-stage turbine of 85 per cent efficiency or better, one stage driving the compressor, and one stage driving the output shaft. Such a gas turbine will be no larger than current reciprocating engines, maintenance will be less, and fuel consumption will be as good or better. It will require no antifreeze, have better torque characteristics than reciprocating engines, use less lubricating oil, and burn kerosene or fuel oil.

Railroad

The key to the size and type of gas turbine used in a locomotive depends largely upon the transmission. For example, the only presently possible way of building a gas-turbine locomotive containing one unit rated at 8500 hp on the Union Pacific is by the use of the electric transmission. Electric transmissions are preferred in the U. S. because maintenance shop facilities are available to all railroads. Facilities are fast becoming available elsewhere due to the diesel locomotive, but certain countries lacking them are concentrating upon the mechanical transmission. Sweden has been developing the Gotaverken supercharged diesel engine which furnished hot gases to a 7-stage axial-flow gas turbine to drive a locomotive which has been in service since 1955 and is giving agood account of itself. The French 1000-hp free-piston-engine locomotive which also drives a mechanical transmission with a gas turbine is performing well.

The British are developing the free-piston gas-turbine unit with mechanical transmission while retaining the electrical transmission for their large gas-turbine locomotives. The Russians are following the British policy.

However, the Czechoslovakians have a mechanical-drive 3200-hp gas-turbine locomotive that has been in operation for the past year. One British firm, C. A. Parsons & Co., Ltd., is developing a similar locomotive with a total rating of 1750 hp. The Czechoslovakian locomotive is burning crude petroleum from a local refinery, which gives a low-cost specially prepared fuel. It is of interest to note that a similar arrangement is used on the Union Pacific. The British unit is at present undergoing rig-tests while mounted on the locomotive chassis and especially equipped for burning pulverized coal.

Nevertheless it was the U. S. Army that put the first locomotive in the world into service with a mechanical transmission and power developed solely by gas turbines, two Boeing units, each rated 150 hp. This entered service on September 23, 1954, and gave a good account of itself. Fuel consumption was high since no heat exchanger was used, but the point was proved that, for Army use overseas and in the Arctic, the gas-turbine locomotive with mechanical drive makes an ideal unit.

The Locomotive Development Committee has completed the third series of tests, burning coal with the open-cycle, gas turbine. C. A. Parsons & Co., Ltd., tests in burning coal are based upon the exhaust-heated cycle and it is of interest to note a similar Russian development. Lacking British metals that will stand the high temperatures in the heat exchanger, they use a second burner just prior to the turbine with oil for fuel.

Marine

The relatively large increase in marine applications leads to the conclusion that the gas turbine is now an accepted prime mover for ships and boats. This has resulted from the attainment of satisfactory levels of: (*a*) Reliability, (*b*) low maintenance, (*c*) low operating cost, (*d*) availability, (*e*) economy, (*f*) low number of operating personnel, (*g*) maneuverability, (*h*) minimum weight, (*i*) small space, (*j*) rapid starting.

GAS TURBINE PROGRESS

Fig. 9 General Electric single-shaft 21.8-mw gas turbine

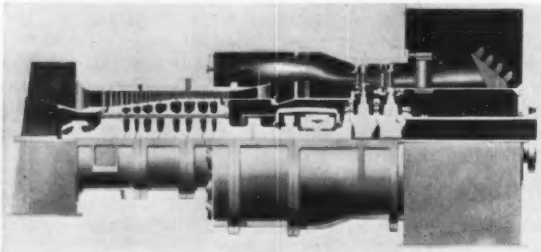


Fig. 10 The Westinghouse Electric 3-mw gas-turbine unit

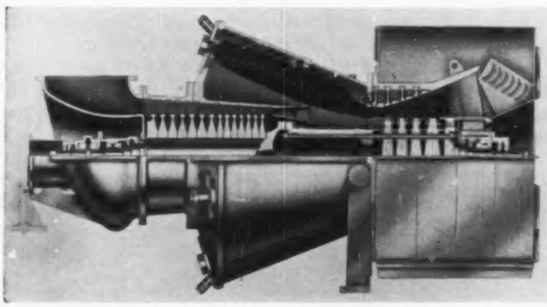
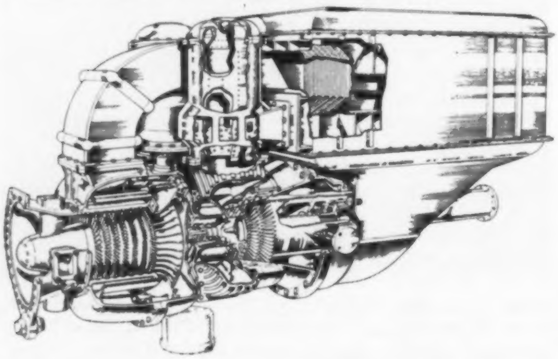


Fig. 11 The English Electric 2750-hp gas-turbine unit



With the development of new-type ships such as 1000-ton hydrofoils, where greatly increased emphasis will be placed on higher powers in small volume, the gas turbine will find increased use. As a result of continued research and development programs of government and industry, turbine over-all efficiencies will be greatly improved. With present materials and techniques, relatively small gas turbines can be put in production in the near future that will have lower specific fuel consumption than spark-ignition reciprocating engines. With the increases in cycle temperatures that will soon be feasible, even greater improvements will be made in reducing fuel consumption. Propulsion gas turbines in large powers are now realities in merchant service, and a number of naval plants are being built. These include both base-load and boost-power units.

Powers demanded for high-speed ships and boats will of necessity require gas turbines. Other prime movers cannot meet the specific power and volume specifications.

Auxiliary applications, both merchant and naval, are moving at encouraging rates. Uses now include: Generators, boiler superchargers, fire pumps, portable generators, fog generators, air-supply units, and aircraft starters. New fields are being explored and present applications are being expanded.

The gas turbine is not expected to replace the steam turbine and diesel in all types of marine service. However, the gas turbine does many jobs more economically than either steam or diesel and the two have been combined, Fig. 8. It is predicted that the gas turbine will be used in the marine field at a greatly accelerated rate.

Industrial and Central Station

Gas turbines have become established, proven components of modern industry, and are no longer experimental units, Figs. 9–11. Table 1 shows the remarkable acceptance they have won in five short years. Dividing gas turbines into three commercial classes—(*a*) Houdry, (*b*) Industrial, and (*c*) Central Station—we find the following number of units and capacity installed, planned, and projected in the given years:

Table 1 Five-Year World-Wide Gas-Turbine Growth

	1952		1957	
Houdry units	40	1,277,000 cfm	7	280,000 cfm
Industrial units	66	320,000 hp	349	2,068,000 hp
Central-station units	44	430,000 hp	128	1,546,000 hp
Totals	150	750,000 hp	484	3,614,000 hp

Houdry units are separated from industrial turbines in this analysis to indicate the "maturity" of the gas-turbine concept. The first unit was installed in 1937, the later ones up to about 1945 for a total of 40 units. Most of these served through 1952, then advanced cracking methods have made the old Houdry process obsolete. Today only seven are still in service. Thus the first generation of commercial industrial gas turbines has served its purpose profitably and has been retired by advancing technology.

Of the industrial applications of gas-turbine units, electric-power-generation and natural-gas-pipeline pumping have an equal number of units, but pumping has about one third more total horsepower capacity.

Oil-field repressuring uses about half as many units as applied to gas-line pumping or to power generation. But repressuring capacity equals about 85 per cent of electric-generation capacity. Oil-line pumping uses only a few less units than repressuring, but has only one third the total capacity.

Chemical processing uses a few less units than oil-line pumping; but its capacity becomes more difficult to define because the gas turbine as a unit sometimes loses its identity to become a part of the over-all chemical cycle.

Refinery and petrochemical units almost equal those for chemical processing, and the former has a total greater capacity, while blast-furnace air supply has the smallest

Table 2 Characteristic Data of Stationary Gas-Turbine Power Plants

Builder	General Electric Company					Westinghouse Electric Corporation			Brown Boveri Corporation					Ruston & Hornsby, Ltd.	Clark Bros. Co.
Capacity, kw, except where otherwise noted	5000	10,000	16,500	21,800	27,500	2400	3750	8500	16,500	2500	6200	20,000	27,000	650	6200
Turbine temperature, F	1450	1450	1450	1450	1450	1350	1350	1350	1350	1200	1200	1200	1100	1340	1350
Pressure ratio	6.0	6.0	6.0	6.0	6.0	4.9	4.1	6.0	6.0	4.6	4.6	16.0	8.0	4.1	4.25
Cycle	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Number of shafts	1	1	1	1	2	1	2	1	1	1	1	2	2	2	2
Shaft speeds, 1000 rpm	6.9	4.9	3.6	3.29		8.5	6.0	4.69	3.6	5.35	3.6	4.75/3.0	3.0/3.0	11.5/6.0	5.0/3.6
Number of turbine cylinders	1	1	1	1		1	1	1	1	1	1	2	3	1	1
Number of turbine wheels in series	...	...	...	...	2	...	2	...	...	...	...	...	DFTC	2	2
Number of compressor cylinders	1	1	1	1		1	1	1	1	1	1	2	4	1	1
Number of intercoolers	0	0	0	0	1	0	0	0	0	0	0	1	2	0	0
Number of heating stages	1	1	1	1		1	1	1	1	1	1	2	2	1	1
Combustor type	Multiple	Multiple	Multiple	Multiple		Multiple	Multiple	Multiple	Single	Single	Single	Single	Single	Single	Single
Regenerator effectiveness, per cent	0	0	0	0		0	75	0	0	75	0	0	80	75	0
Fuel	G, O	G	G, O	G, O	G, O	G, O	G, O	G, O	G, O	BG	G	O	O	O	O
Turbine cooling	Disk	Disk	Disk	Disk		...	...	...	...	D, S	D, S	D, S	...	D, S	D
Compressor type, number of stages	A, 15	A	A, 15	A, 15		A, 14	A, 11	A, 14	A, 15	A	A	A	A	A, 13	A, 13

Builder	English Electric Company, Ltd.	Metropolitan-Vickers Electrical Company Ltd.		Escher Wyss Ltd.	John Brown & Co.	AiResearch Manufacturing Company	Boeing Airplane Company	Solar Aircraft Company		Sulzer Brothers	David Budworth Limited	Utica Division Curtiss-Wright Corporation	
Capacity, kw, except where otherwise noted	1910	1750	2500	2000	2000	100 hp	240 hp	50 hp	520 hp	7500	45 hp	60 hp	2800 hp
Turbine temperature, F	1430	1180	1292	1220	1220	1550	1500	1100	1460	1256	1480	...	...
Pressure ratio	4.8	5.0	5.38	3.6	3.6	3.3	3.95	2.35	4.6	6.6	2.7	2.9	...
Cycle	Open	Open	Open	Closed	Closed	Open	Open	Open	Open	Open	Open	Open	Open
Number of shafts	2	1	1	1	1	1	2	1	1	1	1	1	2
Shaft speeds, 1000 rpm	8.25/7.0	7.0	7.0	12.75	12.75	6.0	35.5/2.92	38.25	20.0	4.25	45.0	46.0	...
Number of turbine cylinders	1	1	1	1	1	1	1	1	1	1	1	1	1
Number of turbine wheels in series	2	...	...	...	...	...	2	...	...	...	...	...	2
Number of compressor cylinders	1	1	1	1	1	...	1	1	1	2	1	1	1
Number of intercoolers	0	0	0	1	1	0	0	0	0	1	0	0	0
Number of heating stages	1	1	1	1	1	1	1	1	1	1	1	1	1
Combustor type	Double	Multiple	Multiple	External	Single	Single	Double	Single	Single	Single	Single	Single	Multiple
Regenerator effectiveness, per cent	60	0	0	90	87	0	0	0	0	77	0	0	0
Fuel	0	0	0	PC	Peat	DO	0	O, K	O, K	BG	0	0	O, G
Turbine cooling	D	...	...	...	None	None	...	...	...	...	...	...	...
Compressor type, number of stages	A-6, C	A, 14	A, 15	G, 3	C, 3	C, 2	C, 1	C, 1	A, 10	A, 21	C, 1	C, 1	...

A = axial flow
BG = blast-furnace gas
C = centrifugal
D = disk cooling
DFTC = double-flow l-p turbine and compressor
DO = diesel oil
G = natural gas
K = kerosene
O = oil
PC = pulverized coal
S = stator cooling

number of applications but the fourth largest total capacity.

The average size of central-station utility units is 12,000 hp or over 9000 kw. For comparison, the largest unit projected—40,000 kw—will be built for the Swedish Power Board by Svenska Tubinsfabrik Aktiebolaget, Ljungstrom, Sweden, for operation in 1959. Units for blast-furnace air supply have the same average size as utility units, while industrial-power-generation units are only about one third as large, and oil-line pumping units use the lowest average capacity.

In addition to the 484 commercial units—industrial utility—there are 36 shop and experimental units in builders' facilities with a total capacity of about 107,000 hp.

The market demand for equipment is reflected in the offering of "standard" models by their builders. This development has been strongly emphasized during the five years in the gas-turbine field.

Careful engineering can adapt these models or their components to the needs of a wide variety of industrial processes. In this way the gas turbine becomes economically competitive with other prime movers. Wider fields of application broaden the opportunity for repetitive manufacture and so help reduce unit cost.

Table 2 does not pretend to be an exhaustive list, but shows the variety of equipment now available. Smaller gas turbines, 500 hp and under, have been applied extensively to military aircraft and naval needs. While they offer possibilities for industrial applications, none have been reported.

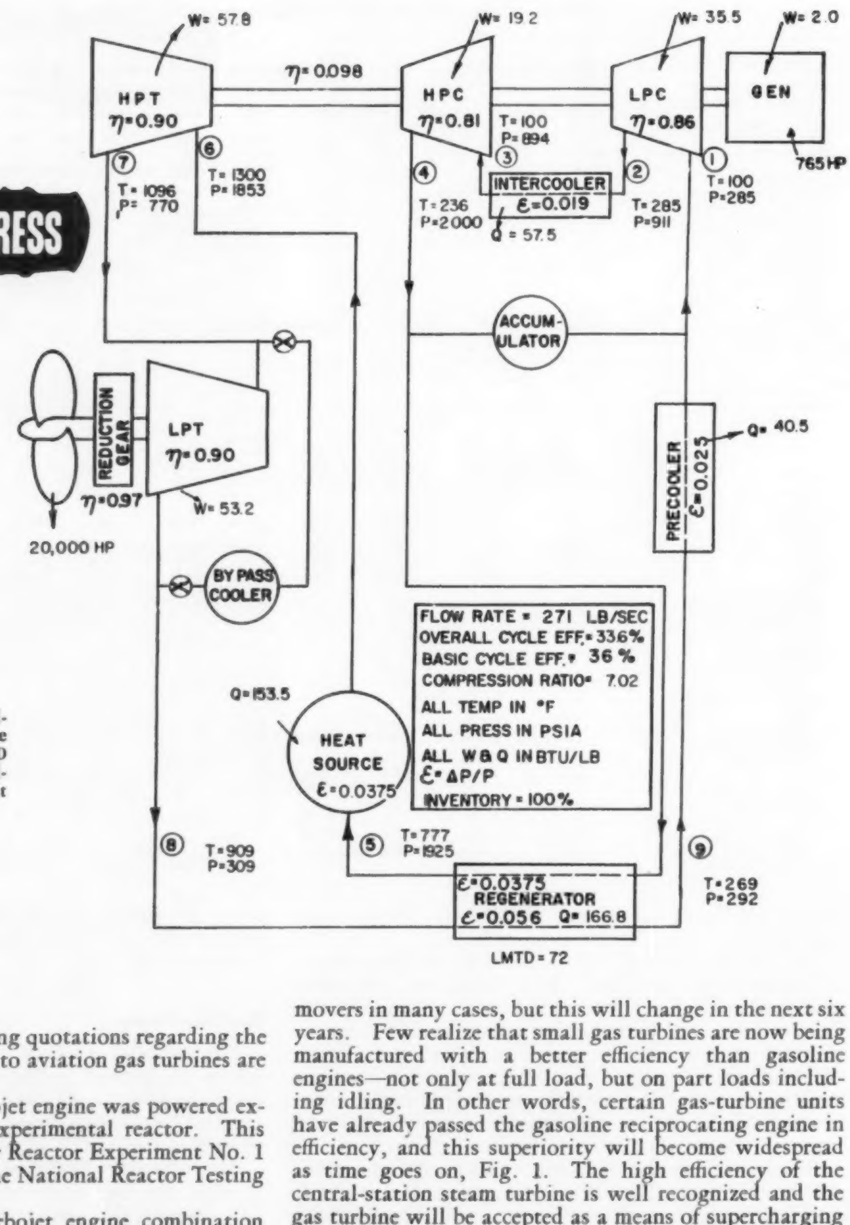
Nuclear Power

The concept of a nuclear gas-turbine power plant, which has proved attractive to many engineers, has become the basis for a substantial development program by General Dynamics Corporation for the Maritime Reactors Branch of the AEC.

The difficulties of this project, particularly in the areas of heat and radiation-resistant materials, are considerable. Several years must elapse before final accomplishment can be demonstrated.

Many cycles have already been examined and present preference appears to be the closed cycle using a single fluid or gas, the gas being either helium or carbon dioxide. The primary objection to helium is its rarity. The main objection to carbon dioxide is its chemical reaction with graphite above 800 F, which reauires cladding with stainless steel or other suitable material. See Fig. 12.

One of the objects of the contract with General Dynamics is to determine which gas should be used in this particular gas-turbine power plant, which would not necessarily rule out the use of the other gas in a similar power plant for another application.



GAS TURBINE PROGRESS

Fig. 12 CO_2 closed-cycle gas-turbine power plant of 20,000 hp, showing heat balance at 100 per cent load

Conclusion

For the record, the following quotations regarding the application of nuclear power to aviation gas turbines are appropriate:

"For the first time, a turbojet engine was powered exclusively by heat from an experimental reactor. This occurred in the Heat Transfer Reactor Experiment No. 1 operating on the ground at the National Reactor Testing Station in Idaho.

"Although the reactor-turbojet engine combination was a laboratory model, the fact that it operated solely on nuclear power marked a significant advance toward the ultimate goal of achieving atomic-powered flight."[1]

"Feasibility studies which the Commission has initiated relative to applying nuclear power to rockets and ramjet engines were continued at Los Alamos Scientific Laboratory, and at the University of California Radiation Laboratory at Livermore."[2]

In summary it can be stated that the efficiency of the gas turbine has not been up to the standard of other prime movers in many cases, but this will change in the next six years. Few realize that small gas turbines are now being manufactured with a better efficiency than gasoline engines—not only at full load, but on part loads including idling. In other words, certain gas-turbine units have already passed the gasoline reciprocating engine in efficiency, and this superiority will become widespread as time goes on, Fig. 1. The high efficiency of the central-station steam turbine is well recognized and the gas turbine will be accepted as a means of supercharging the boiler rather than as replacement for the steam turbine. However, improved efficiency of the gas turbine will, in turn, increase the efficiency of the large central-station steam-turbine plants. Supercharging has been used for many years on the diesel engine, and the most efficient and most popular means of supercharging is now by use of the gas-turbine turbocharger, whether it be 10 or 10,000 hp.

Efficiency of the gas turbine is high in the aviation field, which is the gas turbine's biggest field today. In the next six years the aviation uses will not only expand but the gas turbine will move rapidly into many other areas (including nuclear application) in proportion to the high efficiency produced.

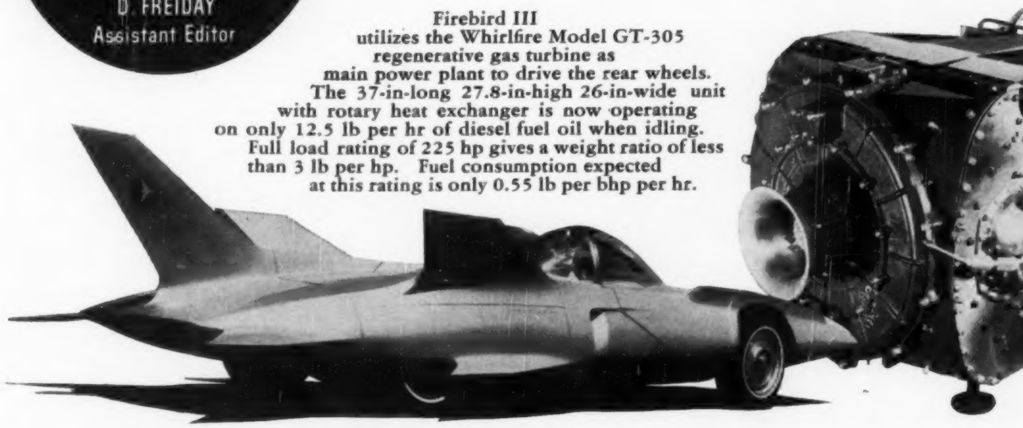
[1] The 21st Semi-Annual Report of the Atomic Energy Commission, July-December, 1956, p. 53.

[2] The 23rd Semi-Annual Report of the Atomic Energy Commission, July-December, 1957, p. 296.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD



Firebird III utilizes the Whirlfire Model GT-305 regenerative gas turbine as main power plant to drive the rear wheels. The 37-in-long 27.8-in-high 26-in-wide unit with rotary heat exchanger is now operating on only 12.5 lb per hr of diesel fuel oil when idling. Full load rating of 225 hp gives a weight ratio of less than 3 lb per hp. Fuel consumption expected at this rating is only 0.55 lb per bhp per hr.

Firebird III

General Motors Research Laboratories and Styling Staff have continued the technique of dramatizing for the public the most advanced thinking of the company's designers, engineers, and scientists, in experimental cars.

Firebird III is a two-passenger, gas-turbine-powered design built around a single-stick control system which eliminates the conventional steering wheel, brake pedal, and accelerator. According to General Motors, it is the easiest-to-drive automobile ever built.

Provision is also made for automatic operation on the electronically controlled highways that have been discussed for future installation. At a touch of a button, Autoguide—the automatic operator—would take over steering control by electronically following a low-frequency-powered cable in the highway. In addition, a constant road speed can be maintained by push-buttoning a third electronic control—Cruisecontrol. This would produce completely automatic guidance and speed control for the car.

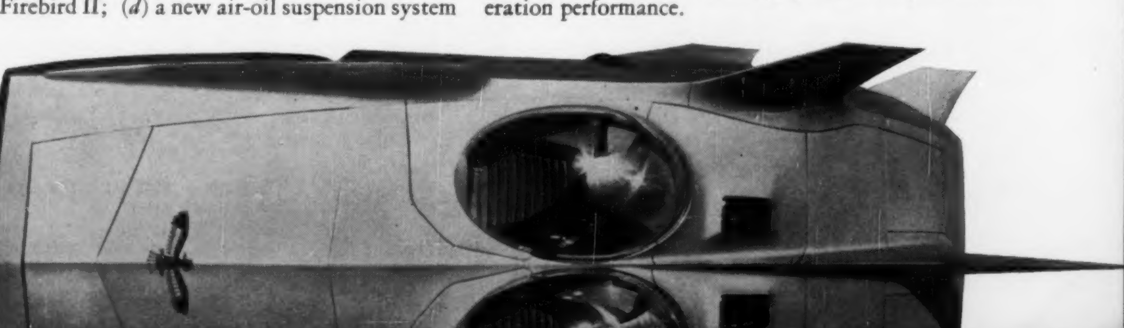
Other primary Firebird III features are: (*a*) Use of a dual-engine system which employs a 10-hp constant-speed aluminum engine to drive all accessories and frees the 225-hp Whirlfire GT-305 regenerator gas-turbine engine to drive the rear wheels; (*b*) a passenger compartment offering maximum access room and maximum comfort; (*c*) an improved gas-turbine engine which is lighter, more compact, 10 per cent more powerful, and consumes 25 per cent less fuel than the gas-turbine engine in Firebird II; (*d*) a new air-oil suspension system that reduces pitching on bumpy roads and offers improved cornering and skid control; (*e*) new Turb-Al brakes with an antiskid device that prevents wheel lockup and resultant skidding; (*f*) the first single-dial electronic temperature system, combining all conventional automotive heater and air-conditioning controls which can maintain a single-temperature setting even though the car be driven from the Arctic to the Equator; (*g*) a centralized nerve center which acts as a brain for the car's advanced controls and folds partly out of the car for quick maintenance.

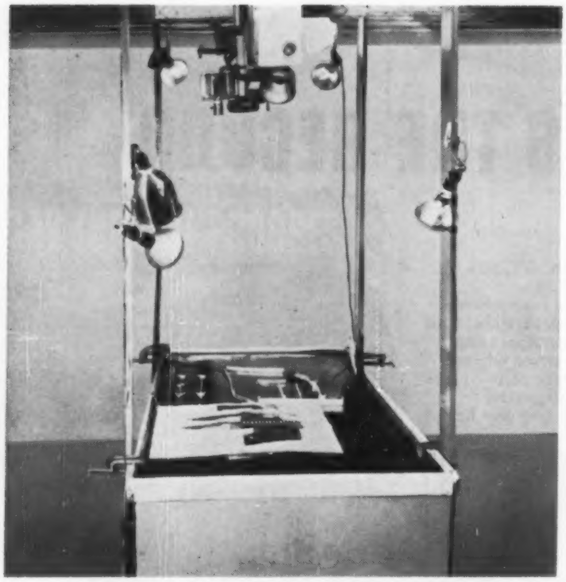
The small 2-cyl engine in the dual power-plant system supplies electrical and hydraulic power for all of the car's accessories. Built with a cast integral-cylinder-head design, it is the first liquid-cooled, high-compression (11:1), high-output aluminum engine without liners in an operational car.

The Whirlfire GT-305 is similar in design to the 200-hp GT-304 engine in the earlier Firebird II. There are two independent gasifier and power sections, with a regenerating device utilizing exhaust heat to conserve fuel. The power turbine is geared through an automatic transmission and differential to the rear wheels.

In addition to the smaller size and simpler construction of the GT-305, design refinements have made possible a 25 per cent decrease in fuel consumption, 10 per cent increase in power, and a 25 per cent reduction in weight.

Provision has been made for two idle speeds. Standby or low-speed idle can be used for long idling periods in order to conserve fuel. A higher idle speed, for normal stop-and-start driving, provides improved acceleration performance.





Water Table for Duct Design

A UNIQUE "water-table" test procedure has been devised by the Buell Engineering Company, Inc., New York, N. Y., for studying the effects of inlet and outlet-duct arrangements upon air-flow patterns within the electric precipitators which the company manufactures.

Since the efficiency of dust collectors is affected by the distribution and smoothness of the gas flow through the collector, it is desirable to design ductwork, vanes, and baffles for uniform distribution and minimum turbulence.

Buell first began utilizing its water-table system as an aid to achieving greater effectiveness from collectors in the field. The success of the system soon led to its adaptation for design purposes and now all preliminary ductwork design is tested on the water table before final design work is undertaken.

Before adapting the water table to general use, tests were conducted correlating water-flow patterns with air-flow patterns obtained in an actual duct. Results were sufficiently close to indicate that the water-table data were reliable and subsequent field results have verified this contention.

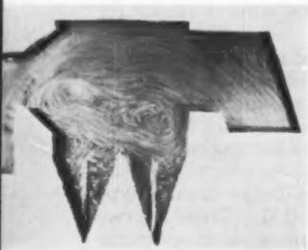
The water table consists of a 3-ft × 5-ft × 5-in-deep table with a water inlet at one end and an outlet at the other. Discharged water is collected in a tank located under the table and is recirculated by means of a $^3/_4$-hp pump. Velocity is controlled by a valve in the 1-in. inlet pipe and this valve is generally fully open. Changes in velocity do not greatly affect the flow pattern, but sometimes it is desirable to study the pattern in "slow motion." Strips of metal 2 to 3 in. high are arranged on the table on edge to form a cross section of the precipitator, to scale of about $^1/_2$ or 1 in. to the foot. The cross section generally represents a vertical plane parallel to the flow through the precipitator. Horizontal distribution is generally sufficiently uniform, but vertical flow can extend into collector hoppers, set up eddy currents, and travel in strata at different speeds. After setting up the scale model, the water is turned on and various vane and baffle arrangements are studied to determine the arrangement which will provide the best air-flow pattern for the particular collector under consideration.

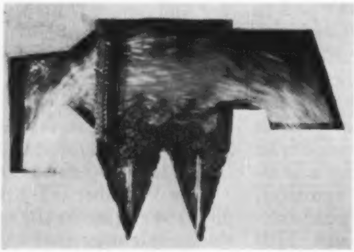
By trial and error, laboratory personnel have devised ways of observing the flow of water. The best method found to date is to dye the water blue with ordinary bluing and then sprinkle it at the inlet with aluminum powder. This creates an effective pattern indicating flow characteristics.

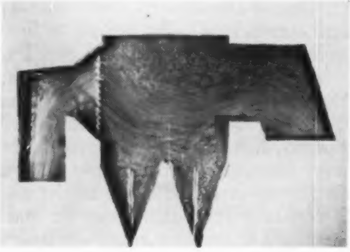
To extend the knowledge gained in the laboratory to the Buell engineering and service force, and more importantly, to make this information available to precipitator users, motion pictures are taken of the various arrangements tried in solving a particular problem. Also, time exposures are taken to indicate results of various arrangements.

It is felt by Buell that the water-table system can be used by any manufacturer confronted with the problem of maintaining an even air or gas flow through ductwork.

This technique is considerably more economical than trial-and-error tests in the field or even three-dimensional laboratory tests, although Buell still uses three-dimensional models for more troublesome cases—such as a recent one involving an inlet duct which approached the collector diagonally.







"Noncombustible" Treated Wood

"NON-COM" pressure-treated wood—a newly developed product of Koppers Company, Inc., Pittsburgh, Pa.—has been classified as basically noncombustible in certain fire-insurance rating schedules, and approved for many industrial-construction applications by Factory Mutual Engineering Division, and the Factory Insurance Association. In addition, Underwriters' Laboratories have tested the product and approved it for labeling at the lowest flame-spread classification assigned to treated wood.

Moreover, Non-Com treated wood has already been accepted as basically noncombustible for insurance-rating purposes by many insurance-rating bureaus and commissions of several states.

Recognition of Non-Com fire-resistant wood by these organizations in effect materially reduces the insurance rates obtainable in construction applications utilizing this treated wood as a structural material. The new fire-retardant chemical used in treating Non-Com is a development of Koppers Wood Preserving Division.

After extensive testing, Underwriters' Laboratories rated Non-Com fire-resistant wood as having a flame spread of 10 to 15 with no evidence of significant progressive combustion in a 30-min-duration test. This approval for labeling by the Laboratories will receive wide recognition from insurance underwriters affiliated with the National Board of Fire Underwriters.

Approval by the Factory Mutual Engineering Division was specifically outlined in their report: Non-Com treated wood "is acceptable without automatic sprinkler protection. . .in Factory-Mutual-insured plants provided. . .that there are no other conditions of construction or occupancy that would normally require sprinkler protection." This certification will be applicable to the insurance-rating systems employed by all mutual-insurance underwriters that are presently members of the Associated Factory Mutuals.

The principal capital-stock underwriters for such special risks as are involved in large-scale industrial installations are members of Factory Insurance Association. This association of over 100 stock companies has concurred in the acceptability of Non-Com treated wood as basically noncombustible.

Power Station on Moon

Elements of an electric power station designed for use on the moon and powered by light from the sun have been demonstrated by the Westinghouse Electric Company. The lunar electric power plant project is dictated by the fact that a United States space base on the moon must, first of all, be self-sufficient.

Westinghouse has a newly formed Astronautics Institute which has developed plans for several space projects. Work also is being done in the fields of space propulsion, communications, and guidance.

Scientists at the applied-research laboratory of the electronic-tube division were responsible for the successful work in the theory, design, and construction of an operating model of the moon station. In this, a modified vacuum tube, containing the same elements that would be used in a full-scale station on the moon, has absorbed a beam of light from a nearby sun lamp generating enough power to drive a small motor.

Basic components of the actual power station consist only of wire mesh and a chemically coated plastic. Giant sheets of a thin plastic material will be stretched and supported over several acres of the moon's surface. Coated on these sheets would be an extremely thin layer about one micron thick of a photosensitive material to utilize the 6000 kw of power per acre which the sun at zenith pours upon the lunar surface.

A thin wire mesh will then be placed parallel to, but slightly separated from, the plastic sheet and insulated from it. The photoelectric generator would then be ready to produce electric power.

As the sun's rays strike the plastic sheet, the coated surface will emit electrons which strike the wire mesh generating a voltage. Upon closing the circuit between the wire grid and the coated surface through a suitable load, current will flow.

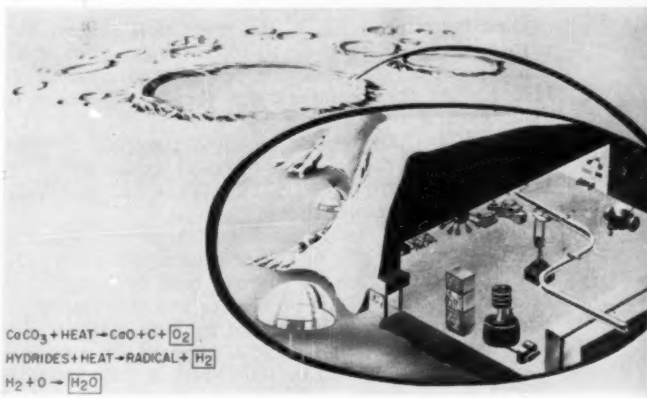
This type of electric power plant is the lightest known with a total weight of about 3 lb per kw.

Since only a few volts are generated by each cell, several cells must be connected in series. This can be done quite easily by separating the sheets into several sections by insulating strips and connecting the section in series. Doing this, practically any voltage, including 110 volts d-c, can be obtained.

A key factor in the operation of such a power supply is that a vacuum must exist as in an electronic tube. Since the surface of the moon is not surrounded by an atmosphere, this condition is present.

Another road block to practical generation of photoelectric power is the internal impedance of the unit. Photoelectric cells constructed in the past had internal impedances in the order of one megohm. Westinghouse-developed cells have impedances of about 3000 ohms, with about 0.1 ohm expected in the near future.

Insight gained into the photoelectric phenomenon of solar conversion now shows promise of generators having up to 25 per cent efficiency. This compares with about 35 per cent for the conventional earthbound generating station. Achievement of this 25 per cent

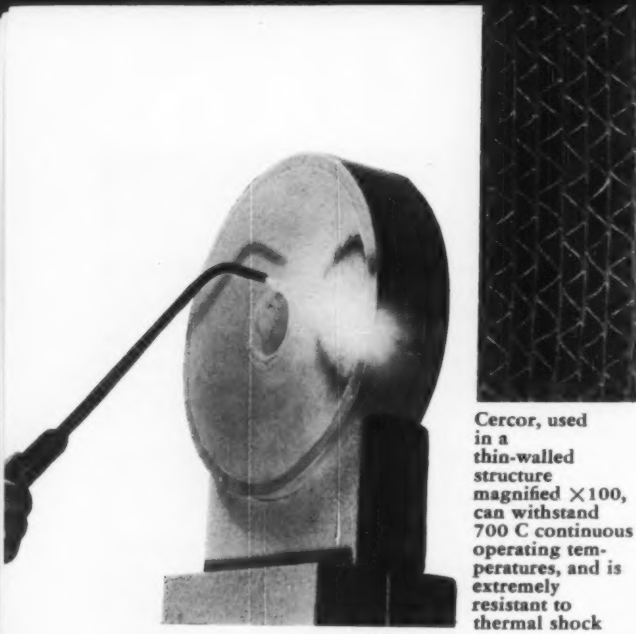


Power station for a strategic lunar base would use thin sheets of plastic coated with a photosensitive layer stretched over several acres with a parallel thin wire mesh insulated from it to utilize the 6000 kw of power per acre which the sun at zenith pours upon the moon

would mean power yields of about 1500 kw per acre on the moon with the sun at zenith.

Once the power station is constructed, it would operate for 14 days at a time since there are 14 days of sunshine followed by 14 nights. A number of these power stations would be built and interconnected all around the surface of the moon to insure continuous power to any point on the moon.

Some of the materials needed to construct the lunar power station may be found on the moon itself although no way is presently available for on-the-moon conversion of such raw materials into usable products. Westinghouse is also investigating ways of determining the presence and properties of the moon's materials through the use of unmanned lunar probes or satellites.



Cercor, used in a thin-walled structure magnified ×100, can withstand 700 C continuous operating temperatures, and is extremely resistant to thermal shock

Thin-Walled Ceramics

Extremely thin-walled ceramics formed into lightweight structures of alternate straight and corrugated layers capable of operating at high temperatures have been introduced by Corning Glass Works.

These materials, made by the new Cercor process, can withstand temperatures up to 1800 F with virtually no thermal expansion, and can operate continuously at 1290 F. At these temperatures they are resistant to oxidation and corrosion.

A unique characteristic of these materials is their extremely low coefficient of thermal expansion—1×10^{-7} per deg C from 0 to 300 C. They can also withstand extreme thermal shock.

The extremely low expansion of high temperatures, and high surface area of Cercor-process materials indicate their future use in gaseous heat exchangers, as catalyst supports, as air preheaters and aftercoolers, as burner plates or covers, column packing material, and as structural materials for use at elevated temperatures.

Cercor structures can be built with a wide range of shapes and properties, and the base material can be any of a large number of ceramic compositions including Pyroceram, the high-strength crystalline material invented by Corning.

Disks 20 in. in diam and $3^3/_4$ in. thick have been made by the Cercor process. A protective rim for the disk which can also be used as a mounting support, is formed by a tough coating of special material with matching expansion and equally high resistance to temperatures.

Available Cercor pieces have a compressive strength, parallel to the channels, of 2000 psi. Surface area of the 20-hole per in. corrugated structures is 1500 sq ft per cu ft of material.

Of the total face area, 75 to 80 per cent is open space. Hole sizes of Cercor pieces are approximately 0.095 in. long and 0.045 in. high. It is believed that the cellular holes can be formed into a variety of shapes with a wide range of dimensions.

The material has a density of about 30 lb per cu ft and a specific heat (room temperature) of 0.20. Average wall thickness of the corrugated structure is 0.005 in.

Soviet Steel Industry

A report on "Steel in the Soviet Union" has been prepared by 19 representatives of the American steel and iron-ore-mining industries who included specialists in general management, industrial relations, ore mining, steelmaking operations, research, metallurgy, and industry publications. The American Iron and Steel Institute has published and distributed a limited number of copies. A similar delegation from the Soviet Union will visit the United States.

"The Soviet steel industry is today the largest steel operation in the world under a single management," the report states. "Supplementing its 1958 capacity of some 60,000,000 net tons of ingots, is an additional capacity of some 18,000,000 net tons in the satellite countries of Czechoslovakia, Poland, Hungary, and East Germany. In relatively few years, Soviet steel capacity has risen to a point where it is about 40 per cent as large as the total steelmaking capacity in the United States. Plans are under way for still further expansion."

Observations of the delegates indicate that probably 80 per cent of the steel produced is for use in State projects, particularly for industrial, power, railroad, and military needs. Only about 20 per cent goes for the manufacture of consumer goods and for export. Supported by fast-growing steel production, the industrial-expansion program has made rapid strides.

While extra manpower and machinery are being used to obtain all possible production, this does not mean that the Russians are not cost-conscious. They are constantly seeking ways to reduce unit operating costs, and the Americans saw some ingenious installations of automation to save labor.

While the Soviet steel industry is achieving high rates of production, it is in many cases producing products of a quality that would not satisfy American customers.

Soviet production of electric-furnace alloy and stainless steels did not appear to be as far advanced as their production of carbon steel in open-hearth furnaces.

Surface quality of stainless steels observed would be considered inferior by American standards. Some conditioning and spot grinding of defects were observed, but there was no over-all grinding to obtain the ultrasmooth surface finish which is required in the American market.

However, where quality improvements were considered very important, such as in ball-bearing and transformer steels, vacuum installations for ladle and steam degassing are sometimes provided.

Research and development are considered of great importance and engage large numbers of people, although the equipment and instruments seen in use were mostly conventional in type and of Soviet make.

The Mechanobr Research Institute, employing about 800 research persons at Leningrad, is an excellent research facility. Staff specialists there are much interested in the structure of ores and are doing a great deal of work with microscopes, mostly at 10,000 to 20,000 magnification. X-ray equipment is being used to study films of minerals.

Other studies include the effect of flotation reagents on mineral surfaces, and the surface area of powders. Some very fine equipment for infrared spectrophotometry was seen in use.

The design section of this institute employs about 700 persons in designing new equipment, constructing models, working with machine-building plants, and acting as

consultants in the starting of new plants. Typical of its work is the design of a large beneficiating plant to treat very lean ores having only 16 to 18 per cent iron content.

The Soviet Union is conducting experimental work on direct reduction of iron ore, but it is not now expected that such a process will make blast furnaces obsolete. Difficulties with reducing gas were mentioned as one of the problems Soviet technicians are trying to solve in this experimental work.

Cheaper Isotopes

A NEW FACILITY at Oak Ridge National Laboratory designed to demonstrate the processing of long-lived radioactive fission products on a pilot-plant scale has started preliminary operations.

The 2-story 62 × 123-ft plant, which cost about $2.2 million is equipped for the separation, purification, and fabrication of kilocurie quantities of such isotopes as cesium 137, promethium 147, cerium 144, strontium 90, and technetium 99.

The five isotopes have a number of applications. Cesium 137 is used in the treatment of cancer and in various industrial processes. Promethium 147 and strontium 90 also have numerous industrial applications such as in self-luminous sources and in atomic batteries. Because of the previously limited availability and high cost, cerium 144 and technetium 99 have not yet found widespread use.

The fission products are obtained from the chemical processing of radioactive waste solutions resulting from the recovery of plutonium and unused uranium from used reactor fuels. The feed for the plant will include waste solutions from ORNL and other AEC reactor-fuel-recovery plants.

The five main radioisotopes being processed in the new plant are among 40 which are created by the fission of uranium atoms during the operation of nuclear reactors.

On the basis of anticipated production of the new plant, the Commission last April announced price reductions on the five long-lived radioisotopes which will be separated in quantity in the plant. The prices generally are about 10 per cent of those formerly in effect.

The plant was designed by the McPherson Company of Greenville, S. C., and was built by Malan Construction Corporation of Long Island City, N. Y. Construction started in 1955. The major process equipment was installed by the H. K. Ferguson Company. Union Carbide Nuclear Company operates Oak Ridge National Laboratory for the AEC.

Sharing Computer Programs

IN ORDER TO START an exchange of computer programs, Westinghouse Electric Corporation is making eight basic power-system programs available to utilities that have gained familiarity with their use at the company's East Pittsburgh, Pa., facilities. It costs $20,000 to $30,000, and requires from 1 to 3 man-years to develop a typical basic program, depending on complexity. The advantages of industry-wide exchange administered by an organization such as Edison Electric Institute are obvious.

In the interim period, while such a clearinghouse is being established, Westinghouse will contribute eight basic power-system programs for use on IBM-704 computers. These will include their older programs, such as economic dispatch, as well as their recently developed short-circuit and transient-stability programs, and others as developed. The other five problem areas involved in the initial series are: (*a*) Self and mutual drop coefficients; (*b*) loss formulas; (*c*) I^2R losses; (*d*) load flow; (*e*) distribution feeder voltage control.

Westinghouse's present services to customers will be unaffected, and those who want assistance in using the released programs independently may obtain consulting service at a nominal fee.

Unique Micrometers and Calipers

A GROUP of new micrometer and vernier calipers recently perfected in Geneva, Switzerland, with unique features, have undergone rigid testing in Europe.

The micrometers, with a reading of 0.0001 in., measure from 0–1, 0–2, and 0–3 in. All have six interchangeable anvils for all-purpose application.

These anvils can be rotated a full 360 deg on a plane parallel to the measuring surfaces, thus making it possible to measure distances between points on different axes. Because of the easy maneuverability of these anvils and their high degree of accuracy, the distinct advantages in terms of labor and production can be readily appreciated.

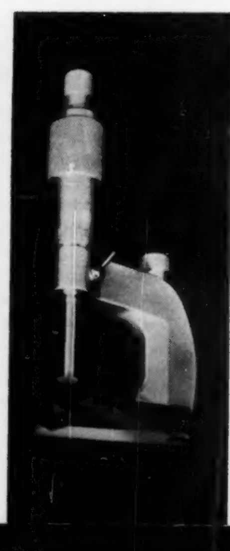
The outstanding characteristic of the calipers, with a reading of 0.001 in., is a hinged lower jaw, which in the 10-in. instrument swings a full 180 deg and in the 7-in. one 360 deg. As in the case of the micrometers, this makes the measurement between points on two separate axes as simple as between those on a single axis with ordinary calipers. Another example of the practicality and time-saving features of Polyplan's instruments is in the measuring of parts in process of machining, which generally can be effected without having them removed.

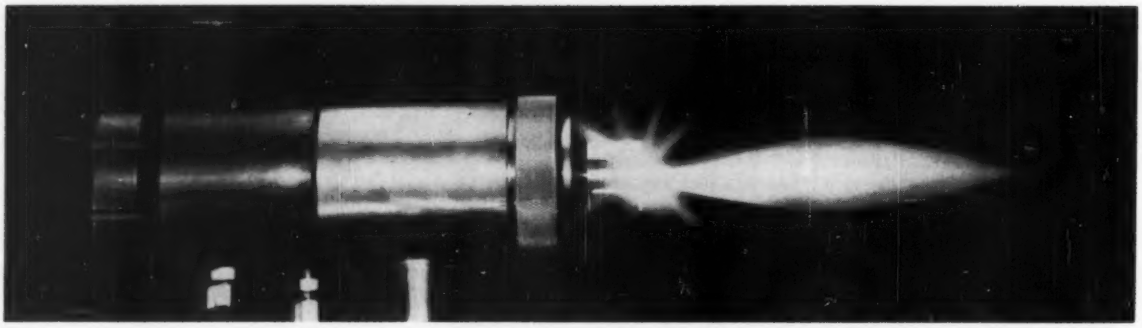
Not an unimportant factor is the scale for angular measurements with the lower swinging jaw. In addition, the broad surface of the jaws, besides affording a surer and firmer grip, will not be affected by friction, as often happens with sharp-edged calipers.

An easy and quick reading of the scales is assured by the photographically etched graduation. The instruments are being imported by Polyplan Company, New York, N. Y.

Caliper-squares permit easy measurement of distances between points situated on different axes

Interchangeable and movable anvils allow universal and accurate micrometer measurements





A heat source more than double the temperature of the sun's surface is provided by a plasma-flame torch which does not require expensive gases

Plasma-Flame Torch

A PLASMA-FLAME torch which allows industry to use a heat source of more than double the temperature of the sun's surface has been developed by the Thermal Dynamics Corporation of Hanover, N. H. Continuous operation at 20,000 F and higher is possible.

The development of this new plasma-flame torch represents a novel concept in design. To allow continuous operation, prior units were forced to use the noble gases such as argon and helium. Thermal Dynamics' torch has eliminated the necessity of such expensive gases by adapting the use of diatomic gases such as nitrogen and hydrogen. The noble gases may also be used. Special attachments allow for the use of air for reasonably long periods.

The plasma-flame torch operates on the principle of the restricted arc. An electric arc is established between one electrode and another electrode which contains a narrow passage. The arc and the plasma-forming gas are both passed through this passage. The major achievement in its design has concerned itself with the spacing of the arc away from the walls of the electrode passage.

The plasma torch is an entirely new heat source. Its development may be likened to the discovery of the oxyacetylene flame at a time when the air-fuel Bunsen flame was the highest available temperature source. In the latter case the step increase of temperature was from 3300 F to 5600 F, or less than two-to-one. The plasma flame represents a temperature increase five times that of the oxyacetylene flame. Thus it is anticipated that all sales for some time to come will be of a research and development nature.

The State of Thermal Power Generation

IN THE past 30 years or so, the heat consumption per kwhr attainable in large stations has been nearly halved, mostly through advances in metallurgy and improvements in the turbine heat cycle. Formerly boiler efficiencies of over 85 per cent were considered noneconomic. Now 88 to 90 per cent efficiencies are used.

These conclusions are contained in the general report of the sessions on Thermal Energy—System Planning at the Canadian Sectional Meeting of the World Power Conference, Montreal, Que., Canada, September 7–11, 1958. R. E. Tweeddale, chief engineer, New Brunswick Electric Power Commission, and W. K. Carruthers, Mem. ASME, chief mechanical engineer, Montreal Engineering Company, Ltd., were the general reporters for the sessions. The report continues:

The better economies now made in the turbine cycle are mainly due to the adoption of: (*a*) High temperature and pressure of steam; (*b*) turbines of very large capacity; (*c*) heating of feedwater by five to nine stages of extracted steam; (*d*) reheating in one or two stages.

Yet the thermal gain attainable by each of these means, and even by their combined use has become sharply asymptotic. This is seen by considering the 325-mw, 5000-psi, 1200-F, double-reheat Eddystone unit near Philadelphia, Pa., with its heat rate of 8000 Btu per net kwhr. This rate is 20 per cent lower than a 10,000 Btu rate attainable with a simpler 100,000-kw, 1450-psi, 1000-F, nonreheat unit. The 20 per cent fuel saving made by the Philadelphia unit will be offset to some extent by its higher capital and maintenance costs, since expensive alloys and elaborate designs are needed for the boiler, piping, valves, and turbine to withstand the extreme steam conditions.

Capacity and Steam-Condition Trends

It is of interest to observe the size and other features of generating units being adopted in countries that have large thermal generating systems.

In the larger part of the capacity installed in the last year or two in the United States, the steam conditions have been 1800 to 2000 psi, 1000 F, with a single reheat to 1000 F. Double reheating has been introduced with a few of the large turbines using the highest throttle pressures and temperatures; for example, the 125-mw Philo unit of the American Gas and Electric Company, now operating, has throttle steam of 4500 psi, 1150 F, and has a first reheat of 1050 F, and a second of 1000 F. The Eddystone unit in Philadelphia will be operating soon and at the highest conditions of all—5000 psi, 1200 F, with double reheat, both stages 1050 F [1].[1]

A thorough analysis has recently been made by a large representative midwest United States utility whose generation is all in thermal stations. The analysis examines all the present and prospective economic and technical factors that would determine the most profitable size and features of the generating units to be added to this utility's system.

[1] Numbers in brackets indicate References at end of the article.

The following observations are made on controlling economies:

1 In their recent unit, 325 mw, a saving of 0.1 mill per kwhr will mean an annual saving of $240,000, equivalent to carrying charges on an investment of $1.9 million. In 1983, the 0.1-mill saving would mean $1 million annually, equivalent to carrying charges on $8.48 millions.

2 The time value of money has an important bearing on thermal economy and obviously to the greatest extent on the savings made in earlier years of operation.

3 Projecting past trends, the analysis contemplates the following suprising inflations in costs during the next 25 years:

	1958	1983
Fuel, per million Btu....	31¢	65¢
Construction, per kw....	$150	$510
Labor, per kw..........	$2.84	$11.40

The analysis arrived at the following conclusions for the Detroit system:

(*a*) Size and type of units—340 mw is today's economic size, and present trends indicate that above the 350-mw unit size the reduction in installed cost per kw will diminish considerably. In general, with vacuums better than 1.5 in. Hg abs at the turbine exhaust flange, cross-compound units with the large multiple exhausts of 1800 rpm low-pressure turbines would give better over-all economy, even though the investment cost is more than for single-shaft 3600-rpm units.

(*b*) Throttle steam—2400 psi, 1050 F is the economic condition. Supercritical pressures with their high temperatures would not be an economic venture even with the thermal gain of 2 to 4 per cent indicated, because serious developmental problems of metallurgy, pipe flexibility, and operation would be involved.

(*c*) Reheat—1000 F was more desirable than 1050 F, because the problems of metallurgy and maintenance increased by the extra 50 F would offset the thermal gain.

Since the extra economy attainable anywhere by these means is asymptotic, the Russian engineers adopt on a large scale the economy of supplying heat as well as power from their stations [2]. Thereby, electric energy can be obtained for about 4500 Btu per kwhr. More than 3 million tons of coal were thus saved in 1956.

Soviet works in 1956 manufactured and installed three 150-mw single-shaft condensing turbines using 2500-psi, 1000-F steam. Boilers made for pressures up to 1500 psi are usually of a drum type and of capacities up to 500,000 lb per hr. For higher pressures, up to 3000 psi, either drum-type or once-through boilers are used. For critical or supercritical steam conditions, the once-through type is employed. An experimental once-through boiler for 4400 psi, 1100 F has been operated with conspicuous success for several years. Turbines of 200 mw are in the planning stage.

The compactness of Great Britain dictates special conditions since transmission costs are not high [3]. The power stations and transmission lines constitute a nationwide state-owned integrated system. Each station is designed for system economy rather than for local needs. A 275-kv supergrid overlying an older 132-kv grid connects the stations. Due to the growing need of the country to import fuel, the coal allocated to power stations is of only a 10,650 Btu-per-lb grade. Although stations are never distant from the coast, many large units are located in the interior near the mines. Cooling towers are used, since few rivers are large enough for condensing purposes. This arrangement, although entailing poorer vacuums, gives a better over-all system economy than would the location of these units on the coast.

The national power system will soon be growing at an annual rate of 2000 mw. The new coal and oil-fired stations planned up to 1962 include the following units: 16 100-mw, 39 120-mw, 14 200-mw, and four 275-mw. The 275-mw units are tandem-compound using 2350-psi, 1050-F steam reheated to 1050 F. Transport limitations set the maximum alternator size at 275 mw. The next step planned is for a 550-mw, cross-compound unit using duplicate 275-mw alternators.

Stations Supplying Electricity and Heat

Poland is very interested in distributing heat as well as electricity from its power stations. In rebuilding the largely destroyed city of Warsaw, its districts are being heated by steam sent from power stations and distributed by an extensive network of pipes. An analysis is made of the following different methods of giving the double supply of power and heat [4].

1 Double-purpose stations in which the one joint supply of power and heat is obtained from either back-pressure turbines or condensing-extracting turbines.

2 Divided-economy arrangements whereby all power is generated in straight-condensing turbines, and all steam in district boiler houses.

The analysis brings out that: (*a*) A back-pressure turbine can produce power for 4400 Btu per kwhr, but the amount of electricity supplied is "forced" by the varying demands for steam, and depends on that demand; (*b*) a somewhat higher fuel expense is incurred in condensing-extraction turbines.

U. S. Electricity-and-Steam Units

In the United States, public utilities have large power stations supplying both electricity and steam to nearby industrial plants and furnishing electricity to their own systems. Numerous pulp and paper plants, and petroleum-refining plants are so served and have been for many years. The arrangement is particularly advantageous to both parties in the case of petroleum plants, where the utility receives waste and residual products as cheap fuel from the refinery, and the utility in turn supplies electricity and steam to the refinery. In several recent cases, the residual is a high-viscosity substance that is solid even at 100 F, and is piped to the power stations in heated lines.

The Esso Standard Oil Company's Bayway Refinery in New Jersey (Mechanical Engineering, June, 1958, pp. 88–89) is a notable case of this practice. It receives steam and power from, and gives high-viscosity fuel to, the Linden generating station of Public Service Electric and Gas Company. This station has two 225-mw, 3600-rpm tandem-compound generators.

The supplying of steam or hot water for district heating is not extensively practiced by the public electric utilities in the U. S. In many cases it would be noneconomic due largely to the high unit fixed charges associated with low annual-load factors. The relative unimportance of steam in the business of a large American public electric utility is shown by the fact that the Consolidated Edison Company of New York obtained only 4.8 per cent of its total operating revenue from this source.

Fuel

The most costly item in generating power in thermal stations is usually fuel. To combat a tendency to rise in price, power stations resort more and more to the use of lower grades of fuel. In power production the efficiency of each step from the coal pile to the generator terminals has been raised: Combustion is more efficient, the steam made has higher temperature and pressure and so more available energy, and it is used to better effect in the turbine. Those measures have given substantial savings.

Great Britain's Central Electricity Authority is supplying 107 per cent more energy than it did ten years ago and uses only 74 per cent more fuel. This improvement has been made although the system is given poorer coal which is 95 per cent slacks and smalls, is mostly uncleaned, and has a gross calorific value of 10,650 Btu per lb. The monetary value of the improvement may be judged by the fact that the thermal efficiency of the power generated on the national system was raised by 0.1 per cent, corresponding to an annual saving of about £ 650,000 at present fuel costs [3].

Russia has gone far in the use of unusual and low-grade fuels, with intensive study of their characteristics, and development of furnaces, boilers, burners, and mills best suited to them [2]. The equipment is giving surprisingly good results. Thirty large power stations burn anthracite dust. Over 40 per cent of the total power generated in Russia is due to the combustion of lignites, peat, and bituminous shales. Some of these fuels have up to 55 per cent moisture content and some a dry-product ash content of up to 60 per cent. Considerable attention has been given to the requirements of large-scale utilization of anthracite fines which have hard particles and require fine grinding for sustained combustion. The burners are of special design and are carefully located. Study was made to determine the best rate of heat liberation in the furnace and to decide the optimum airflow conditions for efficient burning and to prevent slagging. Another most interesting advance is under way. This is a boiler plant now being installed with a cyclone furnace designed for anthracite.

While ball mills are used for coal, beater mills are used extensively for lignite, peat, and bituminous shale because of their simplicity, low power consumption, minimum need of steel and low capital cost.

References

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2 B. M. Sokolov-Andronov, L. M. Mittelman, and Y. I. Bunkin, "Economic Trends in Production of Electricity and Heat by USSR Electric Utility Power Stations Burning Organic Fuel," paper no. 66 B_4/10.

3 J. T. Moore, "Economic Trends in the Design of Thermal Power Stations in the United Kingdom," paper no. 30 B_4/5.

4 Wladyslaw Ney, "Analysis of the Sphere of Application of Steam-Extraction Condensing Turbines in an Electric-Power System," paper no. 13 B_4/7.

Human Mechanical Power Output

Studies, whose outgrowth should be the designing, constructing, and testing of simple mechanical devices designed from optimal power-transfer consideration, have been published in a report by Ezra S. Krendel, "The Mechanical Power Output of Men," Report F-A 1982, The Franklin Institute, January, 1958.

This report had two different goals, namely: (*a*) To organize and compare such data as were available on human power consumption whose paucity has made some rather questionable extrapolations necessary in an effort to fill in the gaps; (*b*) to indicate a scheme which could be applicable to the design of man-machine systems for the most efficient power transfer from the man to the machine.

The first goal is achieved by gleaning from the literature such data on handwheel or crank, pedal, and whole-body-involved work as would present a consistent picture of human power production. Within each grouping was a discussion of power output in terms of continuous-maximum-effort work, maximum-effort work with rest pauses, self-paced work, and power generated over relatively short intervals.

The second goal is approached by setting up mathematical models for transferring power to a useful load when the human operator generates a steady force output and when the force which he produces is a function of time. Further, the author develops the thesis that gross muscular behavior can be predicted in terms of the behavior of isolated muscle fibers. This latter thesis forms the basis for development of mathematical expressions for internal muscle force as a function of muscle tension, for characterizing isotonic shortening, for estimating the power exerted in a single contraction, and for dynamic equations of motion for a muscle pulling against a load.

The author feels that future work in this area should include "the measurement of such dynamic parameters of human behavior or compliances and masses in simple power-producing tasks" in the intact living organism.

Human Factors in Seated Operation

To clarify geometric, kinematic, and engineering aspects of the human mechanism in seated operation; the structure of the limb joints, and the range and type of their motions have been studied on cadaver material, with supplementary work on living subjects. Plans for the construction of manikin joints with normal ranges of limb movement were developed from this information and specifications were also worked out for drafting-board manikins which show correct limb ranges for seated postures. The studies were reported by Wilfred Taylor Dempster, in "Space Requirements of the Seated Operator," WADC Tech. Rep. 55-159, Aero Med. Lab., July, 1955.

Subjects comparable to the model physique of Air Force flying personnel and highly selected small samples of muscular, thin, and rotund builds supplied information on the range of possible hand and foot movements which was consistent with the seated posture. Maximum dimensions of the work space for seated individuals were determined; a study of the kinematic factors involved permitted an evaluation of the potential utility of different regions within reach.

Eight cadavers were dismantled to provide data on such physical constants as mass of parts, segment centers of gravity, density, and movements of inertia. This work was supplemented by data on the distribution of body bulk in the living subjects studied. Applications of the above information to analyses of horizontal push and pull forces, in terms of couples, permitted an evaluation of the effectiveness of body mass, leverages, and support areas.

Supercavitating Propellers

The development of a new "supercavitating" propeller is regarded by the Office of Naval Research as the most important advance in ship propulsion in the past 30 years.

Heretofore, cavitation—the formation of a vapor-filled cavity about speeding propellers—has represented a substantial physical barrier to increasing the speed of ships by propellers currently in use because of the rapid loss of efficiency associated with the onset and development of the cavitated region. When the cavity becomes longer than the chord of the hydrofoil or propeller blade producing it, then the foil or blade is said to be supercavitating. As a result of the discoveries of Marshall P. Tulin, who developed the theory that enabled him to derive low-drag supercavitating hydrofoil profiles, it is now possible to design propellers and hydrofoils having section characteristics, and thus efficiencies comparable with the best noncavitating sections now in use in such machines. Thus for the first time, it is possible to design propellers having performance that is not limited by speed (Phillip Eisenberg, "Research Trends in Naval Hydrodynamics—The ONR Program," *Journal of Ship Research*, June, 1958).

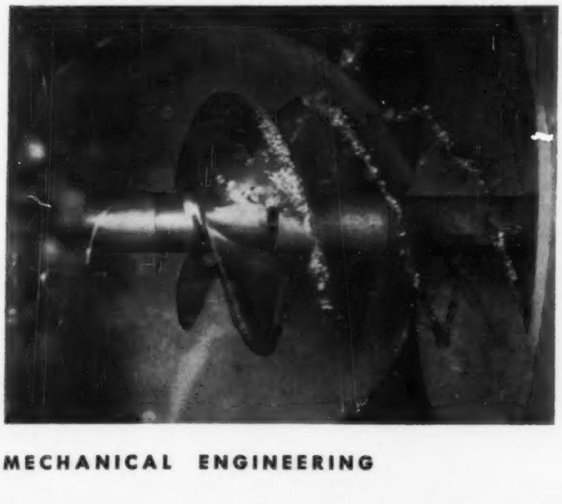
Tulin's theory embodies a linearization of the free-boundary condition, and the boundary conditions are applied on the line of symmetry of the flow in a manner similar to the classical thin-airfoil theory. A singular integral equation formulation was obtained for the boundary-value problem which was then solved to obtain tractable expressions for cavity characteristics and forces on the lifting surface. He was then able to derive camber distributions for minimizing drag (M. P. Tulin, "Supercavitating Flow Past Foils and Struts," in "Cavitation in Hydrodynamics," Philosophical Library, New York, N. Y., 1956; M. P. Tulin and M. P. Burkart, "Linearized Theory for Flows About Lifting Foils at Zero Cavitation Number," David Taylor Model Basin Report C-638, February, 1955).

Work on supercavitating flows was initiated by Mr. Tulin while at the David Taylor Model Basin and continued when he joined the Office of Naval Research; he is presently with ONR's London Branch Office. The first supercavitating propeller utilizing the Tulin low-drag profiles was designed and tested at the David Taylor Model Basin where the research in connection with the propeller application of Tulin's discoveries has been continued by a team headed by A. Tachmindji. The supercavitating propeller has also been tested by ONR and the Model Basin on a high-speed hydrofoil boat—the type of craft that is fully or partially lifted clear of the water while supported on "wings." Studies are currently under way by the Office of Naval Research and the Navy's Bureau of Ships to exploit application of these developments in the design of large ships. Maximum utilization of the propeller's potential will require drastic changes in hull design, and new materials to withstand the increased stresses resulting with operation at much higher speeds. For hydrofoil boats, for example, efficient operation at well over 100 knots will be possible as a result in the near future.

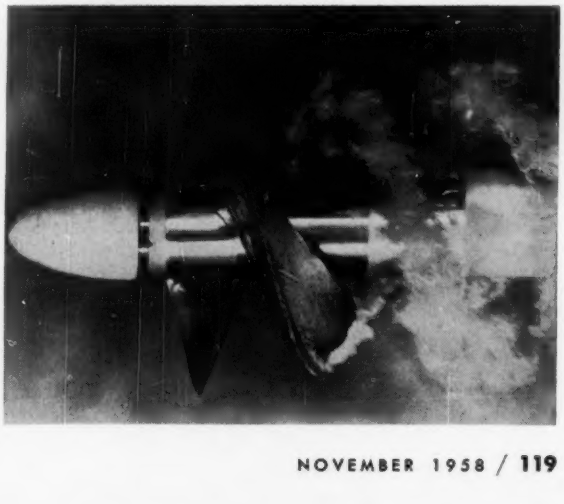
The Navy's program, which since its inception has been under the general supervision of Phillip Eisenberg, Mem. ASME, now Head of ONR's Mechanics Branch, includes, in addition to the supercavitating propeller, research on the use of supercavitating or ventilated hydrofoils—that is, flows in which the cavity is cast by introducing air in the low-pressure region—in pumps, and for the hydrofoils for very high-speed hydrofoil boats, and as take-off gear for high-speed seaplanes. In the latter connection, the Office of Naval Research working together with the Bureau of Aeronautics and the National Advisory Committee for Aeronautics, is sponsoring research and feasibility studies of the use of such foils as take-off and alighting gear for large, high-performance seaplanes having take-off speeds of several hundred knots. Among the basic problems being studied in the ONR program to contribute to all of these various applications are: The behavior of supercavitating hydrofoils near a free surface and in waves—as in the open ocean, unsteady flow including the problem of flutter which may be encountered at the speeds being considered, three-dimensional effects, water-tunnel wall effects, and so forth.

Newest developments in various aspects of supercavitating and ventilated flows were a subject of the recent Symposium on Naval Hydrodynamics. (See p. 154 of this issue of Mechanical Engineering, where a number of recently declassified results are reported.)

Cavitation—the formation of vapor-filled pockets—acts as a drag with conventional propellers, representing a barrier to increased ship speeds



Squared ends on the blade flanges of supercavitating propellers force cavitation bubbles astern, providing increased thrust and removing cavitation limitations on speed



Taped voice instructions leave operator's hands free for an intricate wire-assembly

Taped Voice Instructions

Taped voice instructions, rather than printed words or diagrams, are being provided for manufacturing workers with a system now in commercial production that will be available shortly from Dictaphone Corporation.

AIMO (Audio-Instructed Manufacturing Operation) was developed by Dictaphone in co-operation with Westinghouse Electric Corporation. It has been thoroughly tested at the Westinghouse East Pittsburgh, Pa., plant, where it contributed to a dramatic increase in productivity and cut down worker fatigue markedly.

Two new dictaphone machines, one for recording and one for reproducing instructions, have been designed. The reproducing unit functions at the job site. When the operator is ready for instructions, he depresses the foot control lightly and momentarily. The machine runs automatically until a block space has been reached, when it stops. As soon as the operator is ready for his next instruction, he repeats the process. If he has not understood the instruction, or wishes to double-check it, he depresses the backspace control and the reproducer automatically goes back to stop at the preceding block space. Constant pressure on the backspace control rereels the magnetic tape as far as desired. For the comfort of the operator, a muting switch eliminates all sound whenever backspacing occurs.

Cost of recording and reproducing units totals $1700.

Rotary Forging

Savings in material, weight, and the cost of finished forged parts are now made available to industry through the new Rotary Forging process, being produced at the Metals Processing Division of the Curtiss-Wright Corporation. Now currently producing truck axles and stepped shafts for aviation use, the process provides savings up to 30 per cent in the high-speed production of intricately shaped pieces with close tolerances.

Rotary Forging is the name applied by Curtiss-Wright Corporation for the new forging technique, which utilizes four die-faced hammers to forge a vertical, rotating billet of steel or other premium alloy into a final shape. The Rotary Forge will work hot or cold, using round, square, solid, or hollow billets.

The new Rotary Forge at the Metals Processing Division is the first of a projected battery of similar units that will be installed. Curtiss-Wright is the only company in the United States equipped to produce parts with the new process, which has been widely proved and accepted in Europe during the past eight years, particularly in the automotive industry. It has broad application for use in the production of many forged products for aviation, transportation, petroleum, electrical, and other fields.

In addition to speed and accuracy, Rotary Forging provides considerable savings in the cost of the finished pieces. For example, on axles, shafts, and machine-tool components, previously made by the removal of metal chips, this new technique achieves the final shape by moving the metal, with a substantially reduced loss in material. As-forged parts are as much as 36 per cent lighter than conventional rough forgings. Rotary Forging also gives greater strength because of the continuity of metal flow, which is unaffected by subsequent machining.

In preproduction surveys, Curtiss-Wright engineers have demonstrated a number of advantages for the Rotary Forging process. As an example of attainable speed, a piece having seven outside diameters plus four inside diameters is forged in 40 sec with appreciable savings in material. In another example, the outside contour of a turbine shaft was forged to within a few thousandths of an inch, and the inside surface was shaped with extreme accuracy, using a mandrel. In a cold-forged light gun barrel, the rifling is put into the bore during the forming process. Splining or internal gearing is formed without need for subsequent boring or broaching. Heat-exchange tubes with flanged interior, venturi tubes, and artillery shells have also been produced by the Rotary Forge method. OD tolerances are ± 0.012; inside tolerances are ± 0.004, when extreme precision is required.

Device Prevents Auto Skids

An antiskid device which permits maximum braking effort and at the same time prevents wheel lock and resultant skidding has been developed in Britain from antiskid apparatus now fitted on many civil and military aircraft.

This direct descendant of the well-known Maxaret aircraft antiskid gear is also made by the same company, the Dunlop Rubber Company, Ltd., of London, England. A big future seems to be promised in the automobile field where, despite improved braking efficiency, locking wheels and skidding still remain a danger.

The unit is interposed between the driver's control valve and the brake in such a way that it relays the effort applied by the driver and immediately relieves the

pressure in the brakes when an increase in wheel deceleration gives warning of impending wheel skid. The company claims that the degree of sensitivity is so great that the antiskid units will hold a delicate pressure balance at the brakes at near-optimum braking effort.

The operating principle is simple. A small flywheel, driven from each braked wheel, is decelerated by a spring during braking. If deceleration of the wheel is normal and there is no tendency to skid, the energy given up by the flywheel is not sufficient to collapse the spring and the unit remains inactive. Ultrarapid wheel deceleration, of the type that takes place when a skid is developing, causes the flywheel to collapse the spring. A small hydraulic-valve mechanism is then operated to relieve the brake pressure until the flywheel returns to its normal position as the wheel regains nonslip speed.

Tests have been carried out on a high-powered automobile fitted with hydraulic-disk brakes controlled by these antiskid units. They included some that were really extreme, employing smooth treadless tires running on a specially laid skid track. Tests made at all speeds up to the maximum of 95 mph were highly successful.

Although tests have so far been confined to private cars, this antiskid system is expected to be of even greater advantage on commercial vehicles. Its use would automatically adjust the braking torque at each wheel to the weight carried by the wheel and allow for normal tire-to-ground variations, giving extra safety to heavy vehicles—particularly when used in the articulated or semitrailer types of heavy commercial vehicles.

Nuclear Briefs

▶ Multipurpose Nuclear Power Plant

A Multipurpose Nuclear Power Plant designed to produce radioactive isotopes and provide facilities for testing reactor fuel elements as well as generating 20,000 kw of electricity will be studied to determine engineering and economic feasibility by Atomics International, a division of North American Aviation, Inc., for the Junta de Energia Nuclear, an agency of the Spanish government.

The plant would include a nuclear reactor moderated by deuterium oxide, or "heavy water" and cooled by an organic material.

Tecnatom, a group of private Spanish firms, will participate in the study by providing Atomics International with specifications and estimates on the turbogenerator and other facilities for the conventional or non-nuclear portion of the plant.

▶ Argonne Package-Power Reactor

The 3000-thermal-kw Argonne Low Power Reactor ALPR, the prototype of a nuclear reactor designed to produce electric power and space heat at remote military stations, has achieved criticality at the Atomic Energy Commission's National Reactor Testing Station, Idaho Falls, Idaho.

The ALPR-type plant is a "package" plant with a 3-yr fuel supply designed to be erected on any type of terrain and with a minimum of on-site construction. It contains a direct-cycle, natural-circulation boiling-water reactor fueled with enriched uranium, and moderated with light water. The heat from the reactor can be used to generate 260-kw of electricity and 400-kw of space heat.

ALPR components can be easily transported in Air Force cargo planes. No reactor component weighs more than 20,000 lb or has dimensions greater than $20 \times 9 \times 7$ ft. The facility is designed for simple and safe operation and maintenance, with minimum supervision. It requires a small supply of water because it uses an air-cooled condenser instead of a water-cooled condenser.

Most of the reactor core and all of the fuel elements are fabricated of alloy X-8001, an alloy of aluminum and nickel developed by Argonne. The alloy is expected to help reduce the cost of producing nuclear power because the metal is more economical to fabricate and process than many present fuel-element cladding materials.

▶ A Portable Bandsaw for Hot-Cell Use

A commercial lightweight portable bandsaw at Oak Ridge National Laboratory has been fitted with a grip to permit it to be manuevered remotely in a hot cell by a General Mills manipulator, according to a communication from ORNL Staff Member A. A. Abbatiello, Assoc. Mem. ASME.

The saw tested was a Wallace "Speedy Cut" Model No. 24, weighing about 18 lb. The bandsaw is advantageous for hot-cell cutting since the constant tension of the blade causes the piece being cut to be drawn against the work stop which is an integral part of the saw. Thus the cutting thrust is taken by the saw, and the manipulator provides only the support for the weight of the unit plus a light blade loading.

The manipulator will support the saw in practically all positions, the principal limitation being the clearance required for the bandsaw wheels at either end. A simple fixture may be utilized for replacing saw blades remotely, but it is preferred to remove the saw from the cell and replace the blade manually.

Remotely operated bandsaw supported by a manipulator for a horizontal cut

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PHOTO BRIEFS

1 **Automobile Radiator.** A 20 per cent reduction in raw-material costs and in weight is achieved in an aluminum-fin automobile radiator developed by Alcoa Research Laboratories. Road tested on thousands of cars, it will require only minor changes in manufacturing procedures.

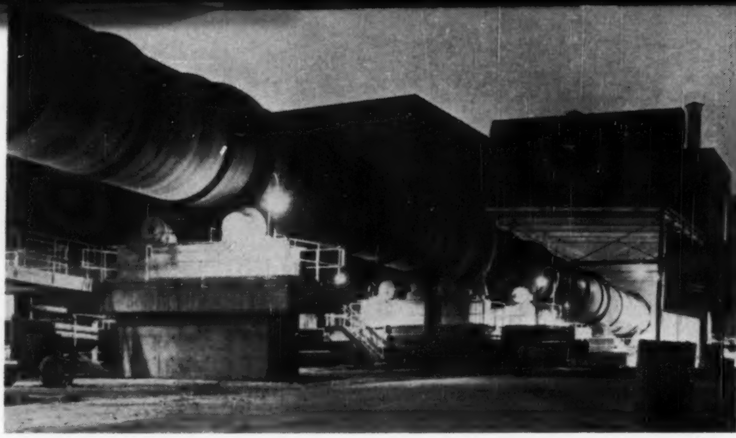
2 **Classification Yard.** The 72 tracks in New York Central's 365-acre Robert R. Young Yard in Elkhart, Ind., near Chicago, can handle 3540 cars.

3 **Hot Welding.** A ring of natural-gas and air flames maintains a constant 450-F preheat to avoid stress cracks in a large chrome-moly-steel welding job by R. C. Mahon Company of Detroit. Center hubs 3 in. thick, and radial vanes were welded to 24 60-in-diam, 3-in-sidewall, 4850-lb gas-turbine cylinders. Work was stress-relieved and final-machined after welding, with warpage and shrinkage controlled within 1/16 in.

4 **Cement Kilns.** The new multimillion-dollar Lime Kiln, Md., plant of Alpha Portland Cement Company has a capacity of 2,250,000 bbl of cement a year. Two 11-ft 3-in-diam rotary kilns 400 ft long are used in the wet-process plant.

5 **Automated Forging Press.** Over 1200 forgings per hr can be produced by Erie Foundry Company's 2500-ton fully automated mechanical forging press.

6 **X-Ray Inspection.** A 24-million-volt betatron built by Allis-Chalmers inspects castings weighing up to 50 tons or more at the New Castle, Pa., plant of Mesta Machine Company. An 85-ton solid-concrete block 13½ ft high, nearly 18 ft wide, and 5 ft thick serves as a door for the concrete enclosure.



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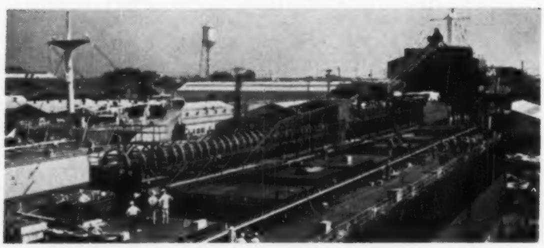
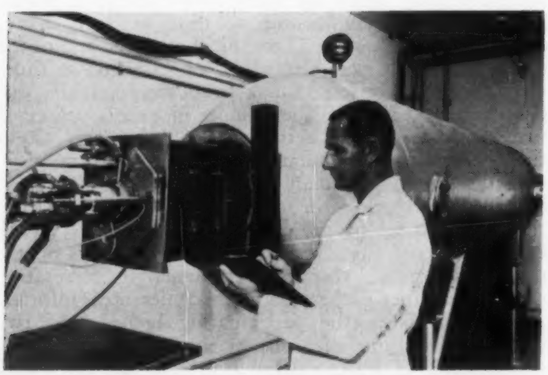
7 Stainless-Steel Tubes. A main steam condenser completely retubed with 9234 Allegheny Ludlum stainless-steel tubes is expected to have better performance and tripled life expectancy at Monongahela Power Company's Rivesville, West Va., station.



8 Self-Discharging Collier. Consolidation Coal Company's 635-ft self-discharging collier recently completed at the Newport News (Va.) Shipbuilding and Dry Dock Company will transport 24,000 net tons of coal at 15½ knots. The 250-ft detergent-spray-equipped boom will unload a ton of coal a second, without dust.



9 Mach 20 Simulation. Thermal effects corresponding to those encountered at Mach 20 are obtained in a 125-sq-ft hyperthermal wind-tunnel test facility capable of continuous operation, and produced by the Giannini Plasmadyne Corporation, Santa Ana, Calif.

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

The Second International Atomic Energy Conference

Atoms for Peace—theme of the Second United Nations International Conference on Atomic Energy. Delegates from many nations met in Geneva, September 1–13.

Sir John Cockcroft, leader of the United Kingdom Delegation to the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, September 1–13, Geneva, Switzerland, on whom devolved the task of surveying its work in a lecture delivered on the last evening, though he spoke for nearly an hour and held the rapt attention of his audience throughout, effectively crystallized it in nine words of his final paragraph. "We have had a rich feast," he said, "perhaps too rich." He did add the safe prediction that "this Conference, like the 1955 Conference, is likely to have a profound effect on the development of atomic energy in the future," which none would gainsay; but it is a reasonable assumption that, in the minds of that great audience, most of whom had shared with him the endurance test of a whole fortnight of meetings and the presentation of more than 600 papers, the earlier comment evoked the most general and sympathetic response, and is the more likely to be remembered in future years.

"A Rich Feast"

At the 1955 Conference, which was summarized in "European Survey" in the issue of Mechanical Engineering for October of that year, there were 1428 official delegates, 1500 observers, and about 900 representatives of the Press and other information services, and the contributed papers numbered 1076. This year there were some 6300 participants from 69 countries and the papers submitted and accepted were 2135—almost exactly twice as many. Obviously, it would have been quite impossible to deal with so many, even though there were 77 technical sessions, and of the 600 or so which were elected for presentation at those sessions, probably less than a third were actually discussed in any detail. The number of papers contained in the official list was actually 2530, but nearly 400 of these were either not submitted or were "withdrawn"; many of them, presumably, either because they overlapped other work or in some way did not come up to the standards set by the examining committee. When it is considered that, in addition to the events on the official program, there were numerous secretarial, social, and other gatherings, press conferences, informal meetings between the participating bodies, and two concurrent exhibitions, one scientific and the other commercial, of quite outstanding interest, Sir John's comment that the "feast" was "perhaps too rich" did not err on the side of exaggeration.

Conferring begins—M. G. Candau, director-general, World Health Organization, speaks. Seated above, *left to right,* Swiss President Thomas Holenstein; Dag Hammerskjold, secretary general, United Nations; Francis Perrin, president of the Conference; Sigvard Eklund, secretary general of the Conference.

International Welcome

The Conference was opened in the Assembly Hall of the Palais des Nations at Geneva on the morning of Monday, September 1, the chair being taken by the President of the Conference, Professor Francis Perrin, and closed on September 13. Its national and international significance was acknowledged by the presence at the opening of M. Thomas Holenstein, President of the Swiss Confederation, who cordially welcomed the delegates, and of Mr. Dag Hammerskjold, secretary-general of the United Nations, and Dr. Sigvard Eklund, the Conference secretary-general.

Mr. Hammerskjold, in a short address of welcome, recalled the "vast declassification" which had taken place at the 1955 Conference, initiating a new era in the atomic energy field, so that ordinary scientific channels of information came to be used much more than previously. It was with great pleasure that he had learned that "some of the very last barriers, guarding hitherto classified information on fusion and on some aspects of the separation of uranium isotopes, have been removed for this Conference." In no other field of science was there a greater need for international co-operation, not only in the provision of nuclear power, but in the regulation of waste disposal and with regard to safety aspects generally. In many countries the question was being asked: How soon could atomic energy contribute to an improved standard of living? No short and simple answer could be given, but he hoped that the Conference would at least indicate when it could be expected that atomic power would become competitive with steam power.

Professor Perrin, in his opening address, had some words of warning for underdeveloped countries, not to expect atomic energy to provide them with everything at once; it was legitimate for them to prepare to use atomic energy, he said, but they should not seek to make early industrial use of it—to do that, they must first train staff, which would take a long time. An underequipped country was essentially an undereducated country. Atomic energy, however, would be found to provide a strong stimulus to the general improvement of education. As his position virtually required, the President surveyed generally the fields that the Conference was to cover, and concluded by paying a tribute to four great scientists who had "gone prematurely from the scene"—Enrico Fermi, Irène Joliot-Curie, Frédéric Joliot, and Ernest Lawrence. "The death, so very recent, of the latter two physicists," he said, "casts a shadow over our Conference, and I propose to you that it should be specially dedicated to their memory."

Mr. Sterling Cole, director-general of the International Atomic Energy Agency, followed with a short address in which he outlined the functions of the Agency, established last fall by a treaty-statute to which 82 nations subscribed, "to apply for the good of all men everywhere the scientific knowledge reflected in your reports to the Atoms for Peace Conference." It had now, he said, set up headquarters in Vienna and was "ready in all respects to carry out any mission in the atomic field consistent with its statute." Already nearly a dozen countries had sought its advice and assistance, and the major atomic countries had offered to make scientists and specialists available to the Agency for short-term assignments. Among the problems with which the Agency would have to deal were those of legal liability arising from the operation of reactors, and studies were in progress with a view to forming a convention of nations as the only solution.

Dr. M. G. Candau, director-general of the World Health Organization, delivered the concluding address of the opening session. He spoke on behalf of all the specialized agencies of the United Nations, showing how they were affected by such questions as the uses and effect of radiation in agriculture, the training of personnel in radiation protection, the biological and industrial use of isotopes, the transport of radioactive substances, and the impact of atomic physics on meteorology.

Technical Sessions

With such an immense number of papers to be dealt with, it was necessary to hold simultaneous sessions. The greater part, therefore, were divided among five sections, A to E, each of which, on most days, held morning and afternoon sessions simultaneously. The first section covered broadly the development in nuclear physics; the second, reactor physics and the operation of reactors; the third, the chemistry of nuclear energy, including the handling of radioactive materials and the disposal of wastes; the fourth, the production of isotopes and their use in industry, biology, medicine, agriculture, and so on; and the fifth, the extraction and processing of the relevant ores, the preparation of fuels, and the properties of reactor materials. These summaries are not precise or complete, for other subjects were also considered, and there was a tendency for sections to overlap in some directions, but they indicate the broad subdivisions.

Photos top to bottom:

Side by side—on tours, at the conference table, in lobbies—the conferring continues

***Left to right:* Sir John Cockcroft, leader of the British delegation, U. K. Atomic Energy Authority, and V. S. Emelyanov, head, USSR Atomic Energy Utilization Board**

Sir John Cockcroft leads a group through the scientific exhibition. *At his right,* Dag Hammerskjold; *at his left,* Dr. Ralph Bunche.

Sterling Cole, director general, International Atomic Energy Agency, and E. R. Gardner, executive director, U. S. delegation

President of the Swiss Confederation, Thomas Holenstein, *far left,* in a group at the exhibition

A small party of American Congressmen at Geneva. Mr. W. Strath, *right,* member UKAEA, chats with Congressmen J. E. Van Zandt, C. T. Durham, and J. F. Floberg.

General Sessions

In addition to these, however, there were eleven General Sessions in which were reviewed and discussed a number of subjects of common interest to all concerned with the peaceful uses of atomic energy; for instance, "The Future of Nuclear Power," "Experience With Nuclear Power Plants," "The Possibility of Controlled Fusion," "The Use of Nuclear Energy for Purposes Other Than the Generation of Electricity," "Plans for the Construction of Nuclear Power Plants," and "Supply and Training of Technical Personnel." Likewise designed to be of general interest, and of even wider appeal, since they were open to the public, were the six evening lectures by leading scientists: Dr. G. T. Seaborg and Dr. Lloyd V. Berkner from the United States; Academicians I. E. Tamm and V. A. Engelhardt from the USSR; Sir John Cockcroft from the U.K.; and Dr. H. Bhabha from India. The last-named, it will be recalled, was president of the 1955 Conference. For the benefit of those who may wish to form, at comparative leisure, a general impression of the ground covered by the 1958 Conference, without having to plough through the 33 volumes in which its proceedings are eventually to be enshrined, it may be suggested that they should study first the papers and reports relating to the General Sessions, and sinter them, so to speak, with the aid of the lectures.

Nuclear Power Production

Applying this method to review the present state of nuclear power production, it appeared, in the first of the two General Sessions on September 2 (the date is important, as will appear), that there were 13 nuclear power reactors operating, with a net useful output of some 200,000 kw. They comprised the three Calder Hall reactors in the U.K., which are supplying current to the national grid; one in the USSR, which has been operating since 1954, but has only a small output; eight in the United States, generating electricity for distribution; and one, the Marcoule plant, in France, which was designed primarily to produce plutonium. This reactor, known as G1, does not supply current for public use; but G2, to go into operation later this year, and G3, planned to go active next year, will both do so. The first two Calder Hall reactors had sent out 730 million kwhr down to September 2, and the Shippingport plant in the U.S., which went on load December 18, 1957, some 90 million kwhr. The emphasis above on the date, September 2, is explained by the fact that, a few days after these papers were presented, the Russians, with no previous warning, produced a film il-

Touring the exhibitions—one scientific and one commercial—the official Government party pauses at the entrance of the United States section

lustrating a nuclear power electricity plant "somewhere in Siberia" of 100 mw, stated to be now in operation and to be the first section of a station which eventually will have a capacity of six times that amount. They would not reveal its name or precise location, but apparently it is the center of a sizable township, complete with a large statue of Stalin, which might serve to date the film, if not the station. The authors of the several papers in this session (W. B. Lewis from Canada, P. Ailleret from France, V. S. Emelyanov from the USSR, W. Strath from the U.K., and W. K. Davis and U. M. Stabler from the U. S.) were unanimous in stating that the operation of their respective reactors had been notably trouble-free; and the chairman (Dr. W. B. Lewis) said in reply to a question that "the promise of the 1955 Conference had been well sustained."

Controlled Fusion

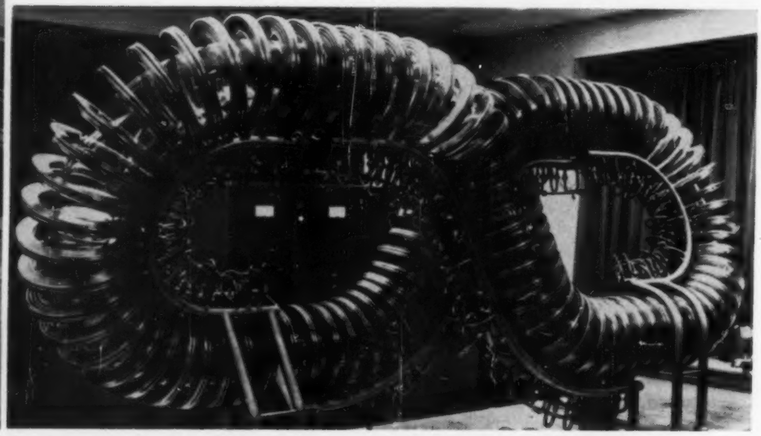
A remarkable amount of progress was reported in the General Session which reviewed the work done in the direction of controlled fusion; particularly remarkable in view of the declaration by Lord Rutherford in 1932 that speculations about using fusion for the generation of electrical power were "moonshine." Dr. P. G. Thonemann (U.K.), who recalled this dictum by Rutherford, went on to say that, if the problems of stability could be overcome, electric power might be generated from fusion reactions in the next ten years; though he added that it would take another ten years to determine whether such a power source would be economically feasible. It was in this field that the progressive "declassification" of research results was particularly marked. Admiral Lewis Strauss and Sir John Cockcroft, chairmen of the U. S. and U.K. Delegations, respectively, had announced at the opening of the Conference that both countries had declassified their programs for research on the control of thermonuclear reactions; and the USSR Delegation (whose members, however, were noticeably resistant to questions designed to elicit more information than was contained in their papers, both in the technical sessions and in Press conferences) presented to the Conferene a four-volume collection of the work of Soviet scientists in the Atomic Energy Institute of the Academy of Sciences which, they stated, contained the whole of their work to date on controlled reactions and plasma physics, none of which had been published previously.

Dr. Edward Teller (U. S.), in a paper on "Peaceful Uses of Fusion," revealed that the United States had several thermonuclear projects in hand, but personally he doubted whether thermonuclear energy would have any practical applications in the present century. He rated the present state of research in this field with that of flying 100 years ago, which drew from Dr. Homi Bhabha the comment that, while this might be so, the effort and skill that were being applied to thermonuclear research today were a thousand times greater than flying was attracting a century ago. Dr. Teller suggested that thermonuclear explosions might someday be used for mining and other peaceful purposes. Later, the formation of artificial harbors was suggested as another application, and a film was shown, indicating how this might be done. It was also stated that there had been a scheme for testing this possibility, somewhere on the coast of Alaska, but that, apart from mere financial considerations, "nobody wanted the harbor."

Ship Propulsion

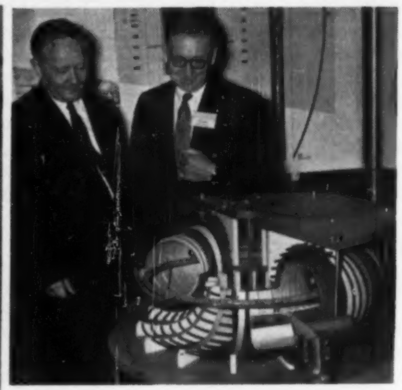
The application of nuclear power to ship propulsion was a topic which aroused considerable interest, probably in great measure because the performance of the United States' submarines so powered had shown that it was a practical proposition. In the two exhibitions also, the models of ships, actual and proposed, with nuclear propulsion were under constant examination; especially the Russian model of the icebreaker *Lenin*, now nearing completion, and that of the *U.S. Savannah* in the United States section. There were British and French tanker models to be seen, and three Japanese authors presented a paper on a nuclear-powered emigrant ship. It was noticeable that, while less than a couple of years ago, there seemed to be a general opinion that nuclear power would not be worth considering for any merchant ship (i.e., tanker) or less than 60,000 tons dead-weight capacity, attention is being directed now to ships of much less tonnage; the *Savannah* will have a displacement of 21,800 tons; the suggested Japanese ship would work out at about 26,000 tons displacement; and designers appear to be coming around to the view that a nuclear-powered tanker of 45,000 tons or so might be practicable. For all that, there was certainly a feeling among those who heard the subject discussed that the nuclear-powered merchant ship will have a hard fight to achieve any sort of popularity in face of the possible reactions of classification societies, insurers, ship repairers, harbor authorities, freight shippers, and the traveling public. If the shipowner has to include psychological resistance among the ordinary maritime perils of waters, winds and rocks, he may be strongly inclined to leave nuclear power to his successors to experiment with.

Portion of U. S. fusion exhibit shows magnetic field pattern of a "figure-eight" shaped Stellarator



Childish wonder—two French lads operate a model of the Dresden nuclear power station

Sir William Montague-Pollock, British Ambassador to Switzerland, and J. F. Herbert, English Electric Company, Ltd., discussing model of Hinkley Point atomic power station now under construction



Professor Emelyanov and Sir John Cockcroft examine model of Russian fission torus, smaller but similar to the British ZETA

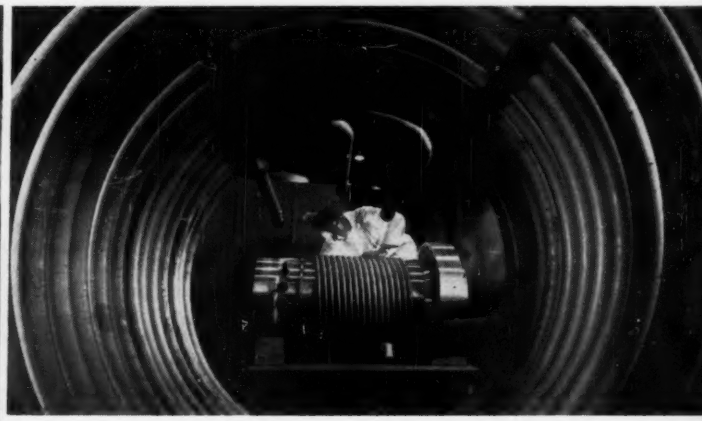
Radioactive Waste

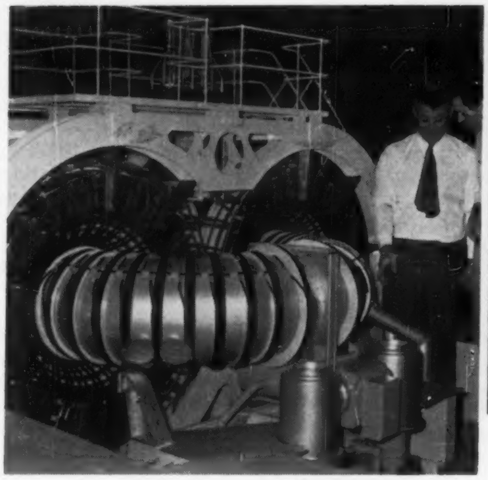
To attempt to scan the whole vast field of the Conference in a limited space is obviously impracticable, but some reference must be made to the question of the disposal of radioactive waste, for this is a problem of universal concern, not noticeably lessened among the delegates by the reports, in various papers, of the effects of radioactivity on horseflies, mice, and other fauna. It divides naturally into two parts, covering, respectively, the waste products of high and low activity. With high-activity wastes, apparently, nothing can be done except to seal them in containers of the maximum attainable durability and to dump them in some place where there is the least likelihood of eventual harm; for example, at sea, in deep water, or in deep abandoned mines.

With low-level wastes, the problem is of quite a different nature; the activity may be of a minor order, but the quantity of effluent that will have to be dealt with in a few years promises to be considerable, and the possible cumulative effects on crops, fish, human beings, and their general environment might build up to serious proportions unless checked in good time. It is estimated, for example, that by 1970 the aggregate output of nuclear power stations will be at least 50 times the present figure of some 200,000 kw. So far, the risk is relatively negligible, the speakers generally agreed, and the fact that it is receiving so much attention in all of the countries concerned is a reasonable safeguard to keep it so. In the coastal waters near the Calder Hall stations, it was stated, where the U.K. Atomic Energy Authority have been discharging wastes into the sea for the past five years, samples of fish, seaweed, and sand from the sea bed and the shore have been regularly taken and examined, and have shown no cause for alarm. A paper by six U. S. authors, collating experience with disposal to the ground at the Hanford, Oak Ridge, and Savannah River plants, indicated that this was reasonably satisfactory with relatively small

Observing the TRIGA-Reactor model: Lewis L. Strauss, chairman, U. S. delegation, Dag Hammerskjold, E. R. Gardner, and Congressman J. T. Patterson

Seen through a set of cooling coils, a canned motor pump with its own wrapping of coils is made ready for Belgium's first atomic power plant. A progress report on plant development was given at the Conference.





Britain's experimental fusion apparatus, ZETA, Zero Energy Thermonuclear Assembly, was shown in quarter scale at the Exhibition

volumes of liquid wastes, when under careful control; this paper covered twelve years of experience at Hanford, seven years at Oak Ridge, and four years at Savannah River.

Exhibits

Of the two exhibitions, the scientific display in a specially erected building with 90,000 sq ft of floor space, in the grounds of the Palais des Nations, and the commercial one in the permanent Palais des Expositions, in downtown Geneva, it can be said that they alone would have provided a conscientious visitor with occupation for a fortnight, if there had been no Conference. Each was visited by some 100,000 persons during its run, even though for part of the time entry was restricted to Conference members. In the scientific exhibition, the United States section undoubtedly led the show. In general interest, that of the USSR would probably have come second on a free vote, with its replica of the nose cone of Sputnik III and the excellent model of the icebreaker *Lenin*. The British section was good, but relatively small, greater effort having been expended on the display in the Palais des Expositions, which was impressive. Broadly, however, it was evident that, in sheer volume of effort devoted to nuclear energy and all the problems associated with its realization, the United States leads the world. Even after studying both exhibitions, the full extent of that effort is hardly to be envisaged, but some notion of it came with a remark, made by Admiral Strauss almost incidentally in one of the Press conferences, that the production of uranium from its ores in the United States absorbs ten per cent of the entire electrical output of the country. That simple statement seemed to provide the best short answer to those who went to Geneva to find out how the practical development of atomic energy was progressing.

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Substance in Brief of Papers Presented at ASME Meetings

M. ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST

Power

Trends in Power-Plant Design for Modern Paper Mills....58—PWR-3

By T. J. Judge, Mem. ASME, International Paper Company, Mobile, Ala. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

The manufacture of paper consists of two separate and distinct operations: (*a*) The conversion of wood into paper pulp; and (*b*) the conversion of pulp into paper.

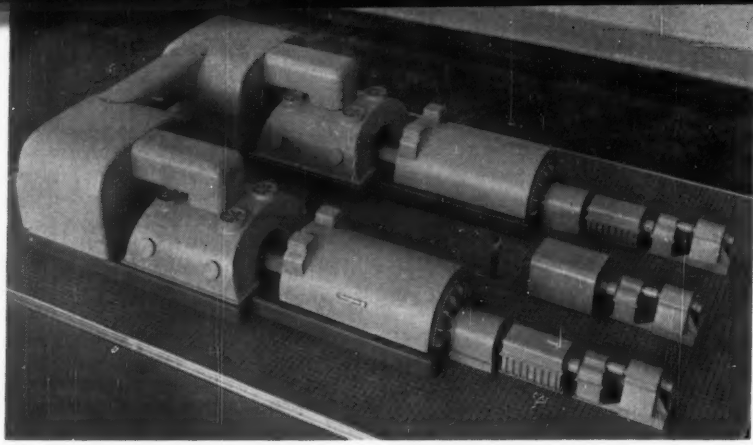
The paper pulp can be manufactured by either a chemical or mechanical process. The chemical process is performed by cutting the wood into chips and cooking them with chemicals and steam in large pressurized digesters. The pulp is then washed, screened, and, if desired, bleached. In the mechanical process, the peeled sticks of wood are defibered by holding them under heavy pressure against huge, revolving cylindrical grindstones, while both the grindstone and the wood are thoroughly soaked with water for cooling and lubrication.

The method of converting the pulp fibers into paper is similar for all types of pulp. The fibers are first subjected to a mechanical rubbing action in large refiners to produce a desired surface on the individual fiber, which will aid the subsequent formation into the sheet. The sheet is formed by filtering a dilute water suspension of fibers on the surface of a moving endless wire cloth screen, where a large percentage of the high water content is drained. From the wire, the sheet is conveyed by heavy woolen felts through several press rolls to squeeze out more of the water. It is then conveyed to a series of large-diameter steam-heated rolls to evaporate the remaining moisture.

These manufacturing operations consume large quantities of steam, water, and electrical power. Steam, at pressures up to 150 psig, is used in the chemical cooking process, for certain evaporating stages, miscellaneous heating, and the paper machine driers. The large quantities of electricity are used principally as power to drive the huge grinders, chippers, refiners, and centrifugal pumps.

The tremendous growth of the paper industry during the past ten years has created an interesting and progressive trend in the design of power plants for paper mills. Much of this progress has been necessary because of changing demands for steam and electricity. During this decade, the electrical requirements at the larger paper manufacturing facilities has grown from 28,000 to as high as 80,000 kw. The capacity of individual generator units has jumped from 7500 to 40,000 kw and of steam-generating units from 200,000 to 500,000 lb per hr. For the larger power plants, it has been necessary to increase the voltage of electrical distribution systems from 2300 to 13,000. The initial steam pressure, properly selected to produce all of the electrical and mechanical power at heat rates as low as 4100 Btu per kwhr or equivalent, has increased from a high of 850 psig, 750 F in 1947, to 1450 psig and 1000 F in 1957. This paper covers some of the high lights of these trends and in general illustrates certain design features of the equipment.

Aerial photograph of paper mill with 27,000-kw power plant. This plant manufactures a high-grade paper product and uses large quantities of steam, electricity, and water which are produced as part of its operation. (58—PWR-3)



Model of Berger turbine-generators Nos. 1 and 2, showing shaft-driven boiler feed pumps and motor-driven spare (58—PWR-18)

Evolution of the Boiler-Feed-Pump Drive. . . . . .58—PWR-18

By R. A. Baker, Mem. ASME, Public Service Electric and Gas Company, Newark, N. J. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

More than a hundred years ago, the horizontal-duplex feed pump was introduced as a drive separated from the main engine so that water could be fed to the boilers when a ship was docked, and the main engine was not needed. Up to that time designers worked toward using the engine to drive its own auxiliaries where feasible.

Today we are witnessing a revival of this concept in large land installations for steam turbine-generators. In the electric-generating stations of the Public Service Electric and Gas Company, this practice has been adopted in the design of four large units now under construction. When the electrical engineers, for good reason, took the exciter away from the outboard end of the main generator shafts of these units, there were persuasive reasons to consider the use of this source of reliable power to drive the biggest power consumer of all the auxiliaries—the boiler feed pump.

The Yankee Atomic Electric Plant. . . . . .58—PWR-13

By W. E. Shoupp, Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa.; R. J. Coe, Yankee Atomic Electric Company, Boston, Mass.; and W. C. Woodman, Mem. ASME, Stone and Webster Engineering Corporation, Boston, Mass. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

The Yankee Atomic Electric Plant is to be constructed utilizing a pressurized water reactor to supply 482,000 kw of heat power and to generate a nominal 134,000-kw electrical power. Special emphasis is being given to make this plant as nearly commercially competitive as possible with conventional steam plants within a time schedule to permit operation sometime in 1960.

To undertake the construction and operation of this nuclear plant the Yankee Atomic Electric Company was organized by eleven of the major New England utilities and was incorporated as a Massachusetts Electric Company. The eleven utilities are the sole stockholders of Yankee and will purchase the entire electrical output of this plant.

To provide for research and development the Atomic Energy Commission has included the Yankee project in its power demonstration reactor program and is assisting by supporting the research and development in an amount up to $5 million. Any excess cost of research and development will be shared by Yankee and Westinghouse. The principal contractors for the design and construction of the Yankee Plant are Westinghouse Electric Corporation Atomic Power Department, and Stone and Webster Engineering Corporation. In addition, Westinghouse will furnish the fabricated core for the Yankee reactor.

The Integration of Single Turbine-Driven Feed Pumps in Large Generating Units. . . . . .58—PWR-11

By J. A. Tillinghast, Assoc. Mem. ASME, and J. E. Dolan, Mem. ASME, American Electric Power Service Corporation, New York, N. Y. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

Five nearly identical units rated at 215,000 kw each and with steam conditions of 2000 psi, 1050/1050 F had been completed in 1954 and eleven quite similar units of the same size and steam conditions were in various stages of erection at the plants of the Ohio Valley Electric Corporation. Each of these sixteen units utilized an arrangement of three constant-speed, motor-driven feed pumps, each rated at one half the maximum boiler flow requirements with flow control by a feed regulating station at the boiler inlet. This scheme had also been incorporated in many other plants prior to this time.

There were several directions in which improved cycle performance could be achieved. Higher efficiencies might have been obtained by going to higher temperatures and supercritical pressures. The supercritical developmental unit at Philo Plant, however, had not yet yielded the experience necessary to apply such a new frontier in steam conditions to existing steam conditions which indicated no further economies over those achieved in the design improvements of the Ohio Valley units. Steam generators for this unit size and rating were already operating at very high efficiencies.

This paper discusses means by which installations in eight plants of integrated single turbine-driven feed pumps and large generating units will accomplish total savings of $2 million.

Advantages to be gained by such a setup are enumerated; pump design, an economic study, the operating cycle, and performance are each reviewed.

Power and Growth—The Challenge and the Promise. . . . . . .58—PWR-7

By F. A. Kramer, Public Service Electric and Gas Company, Newark, N. J. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

The abundant energy of hydrogen-fusion generation will become available within the lifetime of today's young engineer.

The source of energy for hydrogen fusion is sea water. Its energy content is virtually inexhaustible. We are told that just one cubic mile of sea water contains enough energy to satisfy all the world's needs for many centuries.

The dramatic changes which will be produced in the lives of individuals and in the operations of the utility industry, as a result of the abundant energy made available by hydrogen-fusion generation, are forecast.

The author looks ahead to the changing complexion of the public utility of the future, distribution systems, and, indeed, the role of the engineer.

He points up the need for advanced training and expanded responsibilities.

Application of Boiling-Water Reactor for Merchant Ship Propulsion. . . . . 58—PWR-9

By R. L. Schmidt, General Electric Company, San Jose, Calif. 1958 ASME-AIEE Power Conference paper (multilithographed, available to July 1, 1959).

There is increasing activity in the Atomic Energy Commission, the Maritime Administration, and the marine industry directed toward the development and demonstration of nuclear power systems which hold promise for economic merchant ship propulsion. The boiling-water reactor by virtue of the unparalleled simplicity of its thermal system, high cycle efficiency, the use of well-established water technology, and its advanced state of development is the most promising contender for early low-cost nuclear power for merchant ship propulsion. Further, the boiling-water reactor as presently conceived has good promise for (1) increased performance in the areas of higher specific power and improved cycle performance, (2) reduction in capital cost, and (3) reduction in fuel costs. This paper describes the basic features of a marine nuclear propulsion plant which has been proposed by the author's company to furnish 22,000 shp for an oil tanker.

Design of the marine propulsion plant described in this paper is based on established technology, and design limits are backed up by test results and operating experience on land-based nuclear power plants. Special consideration has been given to shipboard power plant and operating requirements. The power plant has been designed to comply with the following criteria:

1 The design, arrangement, and operation of the power plant comply with minimum safeguards requirements established by the U.S. Atomic Energy Commission and the U.S. Coast Guard.

2 The nuclear power plant will (*a*) not restrict the operation of the ship and ship-maneuvering capabilities, and (*b*) ship operational performance is comparable to that provided by a conventional propulsion system.

3 The systems and equipment design are based on established technology.

For purposes of description, the plant has been segregated into (1) nuclear steam-supply system and (2) engine-room systems.

The nuclear steam-supply system incorporates a natural circulation, single-cycle, boiling-water reactor supplying steam direct to the propulsion turbine. The rating of the steam-supply system is as follows: reactor output, 60,500 kw; reactor pressure, 1000 psia.

Engine-room equipment and systems include the propulsion turbine and reduction gear, gland-seal condenser, main condenser, air ejectors, condenser pumps, steam bypass system, feedwater heater, reactor feed pumps, condensate storage system, and associated auxiliaries installed in a shielded area, and the ship's service turbine-generator sets and oil-fired stand-by boiler.

Pumping Power in the Feedwater Cycle. . . . . 58—PWR-2

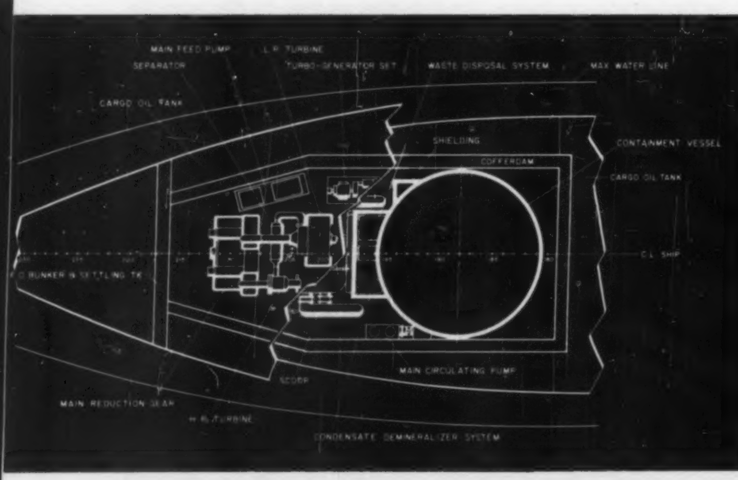
By S. M. Arnow, Mem. ASME, and J. L. Allen, Mem. ASME, Philadelphia Electric Company, Philadelphia, Pa. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

It is well known that less power is used to pump cold water than hot, so that placing the boiler feed pump ahead of the heaters results in a saving of pumping power; also the shaft sealing problem is considerably simplified. On the other hand, the heaters operate at higher pressure which not only adds to the first cost of heaters, valves, and piping, but subjects them to severe operating conditions.

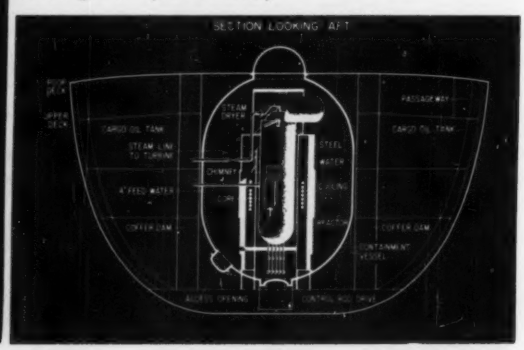
In case of tube failures, it is more costly to open a high-pressure heater with its complicated and heavy closure arrangement than to remove a few bolts which are sufficient to keep a low-pressure heater tight. Moreover, if the feed pump is placed after the last heater, the cycle gets the benefit of the temperature rise in the feedwater due to the work of the pump, which is by no means inconsiderable. In very high-pressure plants, with a desired maximum water temperature, this arrangement permits the highest pressure bleed to be dropped as much as 15–20 psi with no change in final feedwater temperature which in the high-pressure range may amount to a better utilization of work from the extraction point and result in a better thermal cycle, hence a considerable monetary saving.

As to variable speed, some power may be saved by resorting to a step device but one must consider the fact that unless a turbine drive can be incorporated in the cycle, the attainment of this saving inevitably leads to complication of the cycle by the need for additional equipment, such as speed increasers and hydraulic couplings, and the like, at a high first cost plus increased maintenance. The savings are marginal at best, and an occasional loss of the plant due to this extra equipment, may well wipe out the theoretical savings.

Although the boiler feed pump may be called the heart of the power plant, it is not the whole thing, and its position in the cycle must of necessity be governed by the larger consideration of plant pressure and temperature parameters, characteristic of load, cost of fuel, and so on.



Proposed boiling-water reactor for merchant ship propulsion. Plan of reactor upper and lower levels, *left*. Engine-room arrangement, *below*, section looking aft. (58—PWR-9)



In this paper some actual pump installations are described, and the conditions which led to the type of cycle adopted are discussed.

The arrangement of heaters and pumps, the boiler feed pump drive, the selection of the turbine drive, and the many special requirements of the Eddystone Station Unit No. 1 are discussed in some detail.

**Education in Mechanical Engineering for Power Production.........
.....................58—PWR-10**

By J. H. Keenan, Fellow ASME, J. A. Fay, Mem. ASME, and G. N. Hatsopoulos, Massachusetts Institute of Technology, Cambridge, Mass. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

Although the term "mechanical engineer" has been often and variously defined, all attempts at definition are probably doomed to futility. Redefinition by extension is constantly in progress by groups in practice and by groups in education. Any attempt to freeze the definition by limiting it to what most people who are known as mechanical engineers actually do will fail by being ignored. And, if by any chance it could not be ignored, it would fail by forcing the profession of mechanical engineering into obsoleteness.

The scientific and technological advances of the future cannot be foreseen, but, by definition, they will not be those of the past. A well-educated mechanical engineer in the years ahead will be less oriented toward a particular interest, such as the current means of producing power in central stations, and more thoroughly prepared to meet many eventualities with a versatility which draws upon extensive technical resources.

Modern developments in science have opened up many prospective sources of power. These can be exploited adequately only by engineers with a broad scientific training. An undergraduate curriculum in mechanical engineering suited to such training is outlined, and an alternative for the less analytically inclined is suggested.

Education for Expanding Horizons in Electric Power.....58—PWR-12

By G. S. Brown, Massachusetts Institute of Technology, Cambridge, Mass. 1958 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1959).

Any discussion about the education of young men who may take up a career in electric power must fit into the context of today's changing climate of engineering education, and be in step with the changes that may occur in the next decade or so in the rapidly growing area of energy processing.

The proliferation of engineering into many fields has presented engineering educators with an impossible task if they attempt to train students with a specialization that would make them productive promptly upon their first employment. The difficulty that professional societies experience in creating an organizational structure that can cope with the varied and diverse professional group interests within the single field of electrical engineering is an indication of the magnitude of the problem.

Since it appears certain that we will adhere to the four-year program of undergraduate education in most institutions for quite a while, engineering curricula are allocating less time to a treatment of contemporary engineering practice and more time to broadly based science and engineering science. As professors concern themselves with this limited task while continuing to point their interests toward engineering, they find the available time for undergraduate education all too short.

The growing demands for electric power necessitate a constant flow of young engineers into the field. The rapid growth of engineering knowledge is opening new horizons and expanding the opportunities for employment of engineers. At the same time it is necessitating that engineering school curricula be more solidly based on science and applied science at the expense of specialized knowledge. Industries that seek to recruit direct from the college campus need to appreciate the form of the competitive nature of the recruiting problem and to be highly sensitive to the interests and kinds of knowledge possessed by today's graduate.

Petroleum

**The Electronic Computer and Compressor Station Analysis..........
.....................58—PET-29**

By John Manry, III, Assoc. Mem. ASME, Tennessee Gas Transmission Company, Houston, Texas. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Operating management control of the performance and maintenance of over 500 compressor engines has been made more effective through the use of a medium-sized electronic computer. Information that heretofore was virtually impossible to gather for even special studies is now available daily at Tennessee Gas Transmission Company. From the daily compressor station reports, the source data are key-punched and fed into the computer along with a large volume of fixed master card data to produce a computed report, listing for each engine the horsepower-hours, calculated volume, oil use, repairs, and various operating conditions. The different types of compressor engines may now be compared according to their loading conditions, compressing ability, and their parts usage.

Evaluation of Natural Gas Gathering System Design With an Electronic Computer......58—PET-28

By L. R. Henry, Assoc. Mem. ASME, and R. B. Peritz, Colorado Interstate Gas Company, Colorado Springs, Colo. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

A method is presented to determine the pressure distribution in a natural gas gathering system using a high-speed digital computer and the Hardy Cross iterative technique.

The use of the high-speed digital computer in solving this problem has now been proved practical, and can be considered a common engineering department procedure rather than a developing technique in research.

A natural-gas-field gathering system consists of the network of pipelines which collect gas from individual wells in a natural-gas field, and transports the gas to one or possibly to several central points for delivery to a main-line transmission system. Gas wells are usually placed one on each 640 acres; the field served by a gathering system may include several hundred wells. Field compressors are an integral part of the system, and are used to boost the gas through the pipelines, where necessary.

The network can consist of an almost infinite combination of arrangements of locations or routes. These can all be resolved into individual well lines, branch or spur lines, and looped circuits. A loop as used in this paper means a tie-over between branch lines, and not a parallel line to branch, as is commonly intended.

Because there are so many possible routes for the parts of a gathering system, it appears that a specific design technique cannot be developed. Therefore, the problem of design resolves into a study of cases. A trial network design is laid out, the pressure distribution is evaluated, compressor facilities are selected, and finally the cost of service is estimated. The entire process is repeated for another

trial design or variation, and another, until the designer achieves a "satisfactory" plan.

The problem of determining the pressure distribution is straightforward enough in a simple branched spur system. In a network involving several loops, tedious trial-and-error or iterative techniques are required. It has been found that a partly looped system serving about 200 wells requires approximately one man-week to fix the pressure distribution. Thus only rarely has the "study of cases" for the entire field been carried beyond a few trials, and therefore it has often happened that a better plan could have been devised.

By use of high-speed computing machines, the pressure-distribution problem can be solved in a few minutes; it has been found a 200-well design can be reduced to punched cards, processed through the computer, and the results interpreted, in 4 hrs. Thus the designer can investigate a large number of variations, and is more likely to attain the most economical design.

The Use of Digital Computers for Petroleum and Refinery Engineering Problems..............58—PET-24

By R. J. Baxter, Gulf Oil Corporation, Pittsburgh, Pa. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

It is the purpose of this paper to help set the stage for the symposium covering the use of digital computers for refinery and petroleum engineering problems. In a sense, this is somewhat akin to writing an index of the dictionary. It is quite literally true that modern digital computers can do practically any problem that can be performed with pencil and paper, slide rule, or desk calculator. So today, with electronic digital-computer technology a little over ten years old, we find that almost every imaginable type of problem has been or is being performed by using this type of equipment. It is the purpose of this paper to classify and outline the engineering-type work that has been or is being undertaken in the petroleum industry, as well as by the author's company, Gulf Oil Corporation.

Improved Characteristics of a Crank-Balanced Pumping Unit..........................58—PET-22

By J. P. Byrd, Oilfield Equipment Corporation of Colorado, Denver, Colo. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

By altering the geometry of a beam-type, crank-balanced, oil-field pumping unit, thereby changing the basic lever system from first to third class, and making some further simple structural modifications, the operating characteristics of the pumping unit can be improved substantially. The principal change required is the mounting of the speed reducer on the well side of the Sampson post, rather than on the back side. This change makes possible the use of a propeller-type crank which lifts the front of the walking beam instead of pulling down on the rear as in the conventional unit. Among the advantages made possible by this modified geometry are:

1 More beneficial polished rod motion.

2 Variable-stroke length adjustment throughout the normal range, rather than the limited three-hold arrangement of the conventional unit.

3 Semiautomatic counterbalancing, which utilizes the energy of rotation of the unit to translate the counterweight up and down the crank arm.

4 More uniform torque requirements, often resulting in the need for a smaller reducer and prime mover.

5 A more compact unit with a closer coupled prime mover.

A Program for Inspection and Maintenance of Fired Heaters in Gasoline Plants.................58—PET-23

By Peter von Wiesenthal, Petrol-Chem Development Company, Inc., New York, N. Y. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

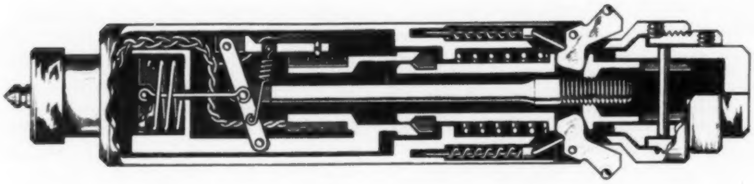
The most important function of inspection and maintenance on fired heaters is the prevention of accidental equipment failure. In addition, the inspection program must be designed to anticipate required repairs and thereby reduce the regularly scheduled downtime to a minimum. Since the amount and type of maintenance are directly affected by the level of furnace loading, the inspection of fired heaters should take into consideration the operating history of the units. This paper deals with the effect of heater operation on the major furnace components such as tube coils, refractories, stacks, burners, and miscellaneous furnace internals. Consideration is given to the inspection procedure most likely to pinpoint serious trouble spots as well as some methods of making repairs.

Minimum Practical Housing of Low-Cost Compressor Stations...............................58—PET-33

By B. J. Thompson, Warren Petroleum Corporation, Tulsa, Okla. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

With the rapid increase in the use of remote-located compressor stations, the installation and operating costs are factors of concern to all operating and construction companies. The manner in which a compressor station is weatherproofed can have a significant bearing on its continuity of operation and cost of operation including maintenance. Examples are included in the paper to show the various housing or weatherproofing methods for stations. Certainly the one most significant factor controlling degree of housing is climate. A second significant condition is the expected duration of operation at one location. Possibly the final factor considered for most remote field compressor units is the amount of finance allowed for the project.

Housing for compressor unit in West Texas consists solely of partial wall shelter (58—PET-33)



Assembly sketch electrochemical caliper for the classification of oil-field tubing (58—PET-9)

An Electrochemical Caliper for the Classification of Oil-Field Tubing.. ....58—PET-9

By W. G. Boyle, Assoc. Mem. ASME, and W. M. Kelly, Otis Engineering Corporation, Dallas, Texas. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

A demand for high-quality tubing in wells created a need for a method of inspection. Calipers were designed, therefore, to measure the internal configurations of the tubing in the well. These calipers have a multiplicity of feelers, each independently loaded against the tubing wall. These instruments have proved satisfactory for inspection of tubing in place in oil wells. The mechanical caliper, however, was not readily suitable for use in pipe yards. Need for greater accuracy and speed prompted the design of a new caliper to measure corrosion pit depths in pipe on the rack.

This paper describes the design of a new type of mechanically sensing, electrically recording caliper for measuring and classifying oil-field tubing according to internal surface defects. The paper discusses design of the structure of the instrument and compares the results of field measurements with the caliper and laboratory measurements using micrometer depth gages.

Testing Methods for Rubber Sealing Materials.............58—PET-31

By A. F. Rhodes, Mem. ASME, McEvoy Company, Houston, Texas. 1958 Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

The problem of testing wellhead sealing materials first received official action at the 1947 meeting of the Committee of Standardization of Valves and Fittings of the American Petroleum Institute Division of Production. The following year, the Subcommittee on Laboratory Methods of Testing Wellhead Sealing Materials was established.

This subcommittee was requested to collect data both from wellhead equipment manufacturers and from the users of wellhead equipment to determine the physical limits and operating conditions to which resilient sealing media are subjected. The requested data included:

1 Clearance of space between pipe and sealing rings.
2 Applied loading.
3 Working temperatures.
4 Physical and chemical characteristics of the fluids passing through the fittings.

This information was to be studied by engineers and rubber technologists to determine the feasibility of setting up standard laboratory testing procedures to establish the suitability of various sealing materials when used as gaskets or sealing media for wellhead fittings.

This paper deals with an eleven-year effort on the part of a subcommittee of the American Petroleum Institute to establish a laboratory method of testing rubber compounds used in wellhead equipment seals around tubular goods. Such a test method was established, and further, it was discovered that this property of a compound could be predicted from the ASTM physical property tests by use of a mathematical equation.

Thermal Analysis and Design of Intermediate Heads in Pressure Vessels..................58—PET-32

By J. T. McKeon, Assoc. Mem. ASME, and G. P. Eschenbrenner, Assoc. Mem. ASME, The M. W. Kellogg Company, New York, N. Y. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Internal pressure heads are being used to subdivide two or more integrally built pressure vessels. At the head-shell intersection, the effect of stresses due to thermal gradients in the head and shell sections is most significant.

This paper covers the influence of these thermal gradients and their analysis for steady and transient-state conditions. The analytical approach gives the general solution, assumptions, and design equations. The use of an electrical analog also is included. Material choice and arrangement of insulation will affect the thermal stresses and proper selection will result in stresses within acceptable limits. Finally, design, fabrication, and inspection details are included which will result in an intermediate head whose cyclic life, quality, and safety may be predicted.

Use of Digital Computers for Technical Calculations in the Oil and Gas Industry..........58—PET-27

By W. S. Pickrell, International Business Machines Company, New York, N. Y. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

There have been two outstanding reasons for the almost unbelievable advancements in the development of high-speed digital computers and their applications to the problems of the oil and gas industry. First, and most important, is that management has at last found a tool with which, together with recently developed mathematical techniques, they are able to base decisions on sound, scientific facts. They are able to study the effect of each little facet of their business on the whole economic operation of their company. These results are not easy to obtain, and it is only because of the large, high-speed digital computer that they are possible. Also the engineer has found that the digital computer has allowed him to spend more of his time performing the tasks for which he has been trained—analyzing results and preparing engineering reports. The engineer also is able to attack larger problems with fewer simplifying assumptions.

Aluminum-Oxide Ceramics in the Petroleum Industry....58—PET-30

By D. E. Howes, Coors Porcelain Company, Golden, Colo. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Ceramics, today, include all products made above red heat which are not metal or gaseous. Ceramics, therefore, include such dissimilar products as glass, refractories, porcelain, chinaware, structural clay products, and such.

Silica, SiO_2, and alumina, Al_2O_3, are by far the most important constituents of ceramic compositions, because, being plentiful, they are relatively inexpensive.

This paper shows how the special high alumina group is being applied to some of the severe applications of the petroleum industry. Many applications are yet to be determined, and, although this material is not a panacea, its amazing performance record in sound areas of usage is creating more and more interest.

Approach, Parameters, and Interpretation of the V-1500 Slush Pump ....58—PET-15

By W. R. Barry, Cardwell Manufacturing Company, Wichita, Kan. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Primary objectives, design parameters, and the over-all approach to the design of the V-1500 slush pump are discussed.

The primary objectives of the new slush pump were to be higher operating speeds and higher operating pressures. Compactness, quality, producibility, a complete analytical approach, reduction in number of parts, serviceability, and appearance were the major parameters.

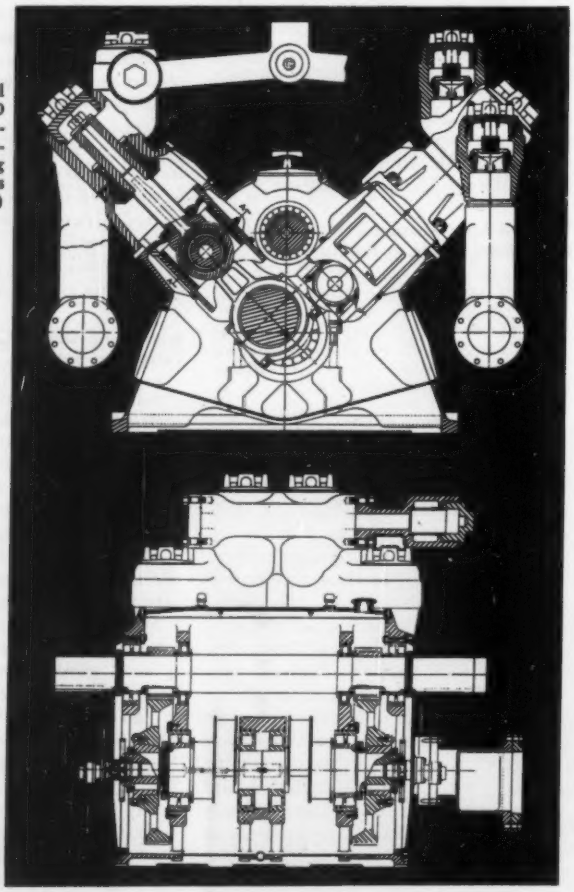
The paper attempts to explain why the V-approach was made. Technical aspects of a high-horsepower reciprocating pump, particularly those which are new to slush-pump design are treated briefly. The adoption of aircraft gearing, the four-plunger arrangement, fluid-end design, valve life and negative pressure, and the packing problem are discussed. An engineering analysis and interpretation of field-test data are given.

Torispherical Shells—A Caution to Designers.............58—PET-3

By G. D. Galletly, Assoc. Mem. ASME, Shell Development Company, Emeryville, Calif. 1958 ASME Petroleum Mechanical Engineering Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.;* available to July 1, 1959).

It has recently become apparent, through a rigorous stress analysis of a specific case that designing torispherical shells by the current edition of the ASME Code on Unfired Pressure Vessels can lead to failure during proof-testing of the vessel. The purpose of the present paper is to show in what respects the Code fails to give accurate results. As an illustrative example, a hypothetical pressure vessel with a torispherical head having a diameter-thickness ratio of 440 was selected. The supports of the vessel were considered to be either on the main cylinder or around the torus. The vessel was subjected to internal pressure and the elastic stresses in it were determined rigorously and by the Code. A comparison of the two revealed that the Code predicted stresses in the head which were less than one half of those actually occurring. Furthermore, the Code gave no indication of the presence of high compressive circumferential direct stresses which exceeded 30,000 psi for practically the entire torus. If the head had been fabricated using a steel with a yield point of 30,000 psi, then a limit analysis shows that it would have failed or undergone large deformations, whereas the Code would have predicted that it was safe. The Code's rules for torispherical heads are thus in need of revision for certain geometries. The implications of the foregoing results are currently being studied by the ASME; in the interim, however, designers should exercise care in applying the Code to torispherical shells.

It is also shown in the paper that the use of membrane state as a particular solution of the differential equations is not a good approximation for toroidal shells of the type considered.



Cross-sectional view of V-1500 slush pump employing modified aircraft-gearing techniques (58—PET-15)

How to Get the Most Hydraulic Power at the Bottom of the Drill String in Rotary Drilling.................................58—PET-6

By R. W. Colebrook, Mem. ASME, The National Supply Company, Houston, Texas. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Power used to pump mud on drilling rigs is increasing steadily. The 500 to 1000-hp mud systems put in service 10 yr ago are being replaced by 1500 to 2000-hp systems.

Much of this power is being added to increase the hydraulic power at the bottom of the hole. Jet bits have proved that penetration rates can be increased substantially by high down-hole power. It now appears that other down-hole mud-operated devices such as reciprocating motors, or turbines, or positive-displacement rotating motors will be advantageous. These devices will further increase the hydraulic power used at the bottom of the drill string.

These developments make it important to examine the means by which hydraulic power is supplied to mud-operated devices on the bottom of the drill string. This paper makes this examination from a theoretical standpoint.

It is shown that the amount of hydraulic power at the bottom of the drill string is influenced by the pressure/flow characteristics of the device operated by the mud. It indicates which characteristics must be met in order to get the maximum hydraulic power down the hole. The effects of using mud-operated down-hole devices with various pressure/flow characteristics are considered. Probable future mud-pump power requirements are discussed.

Evaluation and Development of Technical Personnel.....58—PET-8

By W. E. Alexander, Monsanto Chemical Company, Texas City, Texas. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

The primary purpose of a personnel evaluation and development program is to bring about the most efficient and effective productivity of an organization. To do this, we must help each employee to develop and utilize his capabilities to the maximum. We must provide an appropriate organization and atmosphere in which he can work and develop. Plans for financial and organizational advancement must be fundamentally sound. Functional or geographic relocation must have a logical basis. Reliable knowledge must be available on potential replacements of key personnel, both from within and from outside the organizational group. Last, but not least, a fair and equitable basis must exist for termination of those whose capabilities fail to meet requirements.

Creativity and Brainstorming............................58—PET-7

By A. B. Wintringham, Ethyl Corporation, Baton Rouge, La. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Brainstorming is a special type of conference in which ideas have the floor. A brainstorm conference differs in one important respect from the average conference we are used to. In a usual meeting someone with an idea says "I think we should do it this way." You can almost see the resistance to change building up and people come out with discouraging statements—"It can't be done, it's against company policy." That would be too great a deviation from our established practice." These phrases, and there are thousands of them which are familiar to all of us, are called "killer phrases." They represent snap evaluation and result in stifling creativity. Mr. Alex Osborn, of the advertising agency, Batton, Barton, Durstine, and Osborn, noted these phrases popping up in meetings on sales problems in his advertising agency. One day he hit upon a simple solution. Give ideas a green light. Hold back criticism, suspend judgment, prevent debate and ridicule until all of the ideas are out on the table. Thus brainstorming, as we know it, was born.

Included in this paper are rules for preparing, for conducting, and evaluating the product of a brainstorming conference. No single procedure will solve all problems but brainstorming may be another technique to consider in problem-solving sessions.

Recruiting Engineers...58—PET-11

By R. G. Alleman, E. I. du Pont de Nemours & Company, Wilmington, Del. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

From the 1920's, when a few college campuses were visited, the du Pont Company's college recruiting program has become increasingly centralized with a staff which interviews thousands of students annually at many colleges and universities. The company usually starts new employees at the "grass roots" level, rotates these people for training, and promotes them as opportunities arise. For the most part, those who interview technical graduates have similar degrees themselves, spend many hours acquainting themselves with all facets of the company, visit plants, laboratories, and sales offices, and have continuing recruiting responsibilities at certain colleges and universities.

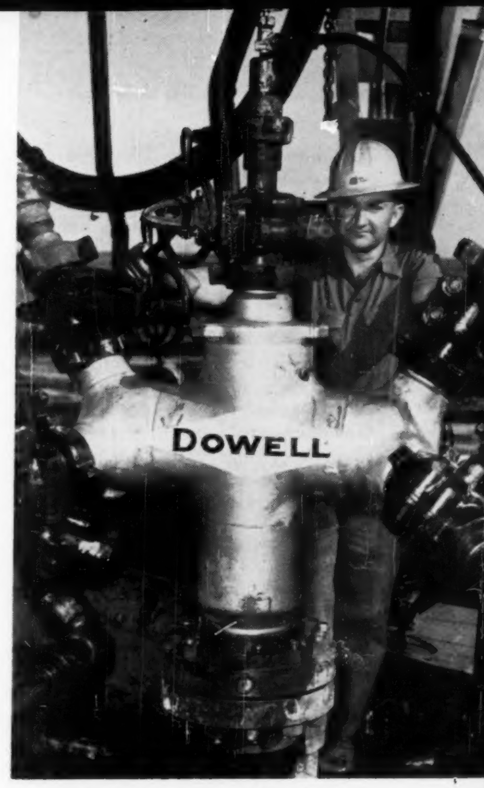
This paper describes preparation for the interview, the interview itself, a candidate's visit to the company, and the subsequent negotiations which may result in his placement. The summer employment of college students is described and the new code of ethics resulting from competitive recruiting is mentioned.

New Fracturing Header and Discharge System.........58—PET-2

C. A. Pitts, The Dow Chemical Company, Tulsa, Okla. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Modern fracturing techniques call for large quantities of sand-laden fluid to be pumped into well heads at high injection rates and frequently at high pressures. In most cases, several pumping trucks, operating simultaneously, are required to supply the horsepower necessary to perform a present-day fracturing job. As a result, with multiple lines, ball injectors, and pressure gages, all tied into the well head, rugged, dependable equipment is necessary if the job is to be performed safely and efficiently. These requirements have been met by using newly designed fracturing equipment, including a new type of treating line, improved valves and swivel joints, and a new high-pressure header.

The new high-pressure header, offering increased safety, durability, and convenience, has been built to connect to the well-head discharge lines from as many pump trucks as necessary, together with any other related equipment that may be required. The header is also designed to prevent back flow from the well in case of accidental line failure. The truck-mounted pump ordinarily used with this header has an overspeed control which stops the pump immediately. It is believed that this new header will be a big step forward in eliminating disastrous well fires such as have occurred in the past.



Fracturing header's flexibility in hookup arrangements is shown in on-the-job photograph (58—PET-2)

The header consists of three basic parts, the goat head, the casing adapter, and the cross. These units are assembled in such a manner as to provide the necessary well-head connections for any particular job.

Steady-State Creep Analysis of the Weight Loadings of Furnace Tubes on Multiple Supports...................................58—PET-14

By J. L. Jacobowitz and C. K. Mader, The M. W. Kellogg Company, New York, N. Y. 1958 ASME Petroleum Mechanical Engineering Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.*; available to July 1, 1959).

The specifications of many companies often contain rules limiting the extent of furnace tube spans regardless of varying conditions of temperature, material, or type of service. A typical rule is to keep the span within a minimum of 25 diameters and a maximum of 35 diameters. The origin of these rules is obscure. In practice, the lower limit (and sometimes

even shorter spans) have been arbitrarily selected for large tube diameters in extremely high-temperature service. On the other hand, the 35-diameter limit has usually been rigidly maintained even for small, thick tubes operating below the creep range. The technical literature, in general, has apparently ignored this problem.

In addition to finding a rational method for setting tube spans, another objective of this investigation has been to achieve economies by reducing the number of alloy support castings and main structural frames required in a furnace, these savings being reflected in lower furnace material and erection costs. An additional aim has been to eliminate clumsy layout problems often arising because of tube support spacing restrictions in furnaces with multiple stacks or multiple tube diameters.

Analysis of creep stress-strain relationships is made for horizontally supported furnace tubes including the effect of tube weight and internal pressure. Steady-state creep effects through the tube wall due to axially symmetrical heat input are also analyzed for these conditions. The original Bailey approach to the pressure problem only is extended to the larger scope undertaken. Maximum permissible tube spans are derived based on accepted criteria for creep stress and deflections.

The results of this work indicate that maximum allowable tube spans may often be theoretically increased beyond present usual design limits except for a few specific materials and instances where short spans are required at very high temperatures. In actual tube design, consideration should be given to experience in operation of any particular type of furnace so that secondary effects may be minimized. Increased economies in costs and flexibility in furnace layout as well as rational span determination are expected from use of these results.

Mass-Flow Metering... 58—PET-16

By L. L. Laurence, Black, Sivalls, and Bryson, Inc., Oklahoma City, Okla.; and H. E. Trekel, General Electric Co., West Lynn, Mass. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Accurate metering of hydrocarbon fluids is vital to almost every operation in production, transportation, processing, and marketing of petroleum. Mass-flow metering, the subject of this paper, is defined as "a method of measuring the quantity of matter flowing past a point by continually measuring its inertial momentum and comparing this with a standard."

Mass flowmeters have been used widely to measure the flow rate of aircraft fuel. This same principle has been applied to mass flowmetering of natural gas and appears to be potentially applicable to most hydrocarbon fluid-metering problems.

The accuracy of a mass flowmeter is a function of only three factors: (*a*) The mechanical repeatability of the metering device; (*b*) the accuracy of the prover against which the metering device is calibrated; and (*c*) the accuracy with which the meter is calibrated against the prover. Mass flowmeters are inherently more accurate than other measurement devices requiring the development of special equipment and techniques for calibration.

This equipment as well as the applications, design, and theory of mass flowmeters as applied to metering natural gas and other hydrocarbons are discussed.

Pipe Stress in Offshore Pipeline Construction.......... 58—PET-17

By Noah Roads, Tennessee Gas Transmission Company, Houston, Texas. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

As the search for oil and gas reserves moved into the open waters of the Gulf of Mexico, the accepted methods of constructing suitable gathering pipelines to the proved areas were no longer adequate. New methods and new equipment had to be developed for constructing pipelines.

The 1957 expansion program of the Tennessee Gas Transmission Company included one such gathering system of 12-in. to 26-in. pipe in water from 10 ft to 60 ft deep.

Pipes of these diameters will float unless extra weight is added. It was decided to use a heavy concrete coating in addition to the usual pipe enamel and wrapper for this purpose. A study was made of the stresses which might be encountered by the pipe and coating during laying operations. Conditions causing excessive stresses were found to be: (*a*) Buckling or weakening carrier pipe; (*b*) concrete coating falling off due to excessive bending; and (*c*) excessive cracking of concrete coating.

Three methods of constructing offshore pipelines are considered: negative buoyancy, point support, and launching shoe. The derivation of formulas is discussed with special emphasis on the negative-buoyancy method.

From this analysis and derivation the company has established specifications and evaluated various contractors' proposals of construction methods.

Epoxy Resin Coatings—Factors Affecting Their Selection and Performance.................. 58—PET-19

By C. M. Jekot and A. J. Da Valle, DeSoto Paint and Varnish Company, Division of United Wallpaper, Inc., Garland, Texas. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Epoxy-resin finishes, in general, provide a tough, thick film having excellent chemical resistance and durability under various environmental exposures. Epoxy

ASME TRANSACTIONS

The October, 1958, issue of the *Transaction of the ASME* (available at $1 per copy to ASME members; $1.50 to nonmembers), contains the following technical papers:

Analysis of the Effect of Pulsations on the Response of Mercurial-Type Differential-Pressure Recorders, by R. J. Martin and D. S. Moseley. (57—A-82)

Subcritical and Critical Flow Through Straight-Through, Elbow, and Tee A-N Fittings and Sharp-Edged Orifices at Elevated Temperatures, by A. L. Ducoffe, J. R. Bennett, and C. G. Ray. (57—A-60)

A Method for Predicting Supercompressibility Factors of Natural Gases, by R. H. Zimmerman, S. R. Beitler, and R. G. Darrow. (57—A-69)

Dimensionless Correlation of Coefficients of Turbine-Type Flowmeters, by H. M. Hochreiter. (57—A-63)

Liquid-Flowmeter Calibration Techniques, by M. R. Shafer and F. W. Ruegg. (57—A-70)

Thermal Transfer in Turbulent Gas Streams—Effect of Turbulence on Macroscopic Transport From Spheres, by Kazuhiko Sato and B. H. Sage. (57—A-20)

Transient Temperature and Thermal Stresses in Skin of Hypersonic Vehicle With Variable Boundary Conditions, by Shih-Yuan Chen. (57—A-9)

Boiling Heat Transfer to Water Containing a Volatile Additive, by G. Leppert, C. P. Costello, and B. M. Hoglund. (57—A-81)

Comparison of Total Emittances With Values Computed From Spectral Measurements, by J. T. Bevans, J. T. Gier, and R. V. Dunkle. (57—A-29)

An Investigation of Effective Thermal Conductivities of Powders in Various Gases, by R. G. Deissler and J. S. Boegli. (57—A-110)

Effect of Vibration on Heat Transfer From a Wire to Air in Parallel Flow, by R. Anantanarayanan and A. Ramachandran. (57—A-100)

Local Laminar Heat Transfer in Wedge-Shaped Passages, by E. R. G. Eckert, T. F. Irvine, Jr., and J. T. Yen. (57—A-133)

systems can be recommended for applications involving exposures to corrosive mediums, except those where extremely strong oxidizing agents are present.

The value of epoxy resins as metal protective and chemical resistant finishes has been demonstrated both by field performance and laboratory test programs. The term epoxy resins, however, covers several types of finishes each of which has specific properties particularly advantageous in individual applications.

Cold-curing catalyzed epoxies are particularly suited to tough coating requirements under severe corrosive conditions because of their marked resistance to alkalies, acids, and solvents. The airdry epoxy coatings can be used to advantage where the corrosive conditions to which they are exposed are not extremely severe, but yet are too severe for ordinary finishes.

Heat-cured epoxy finishes find their most important application as a hard, resistant coating for tank-car, tank-truck, and drum linings, as well as processing vats or tanks that are exposed to a variety of strong gases and liquids.

Effects of pigment upon the performance of epoxy-resin finishes and the importance and techniques of surface preparation are outlined.

Environmental factors and all other conditions must be analyzed in order to determine the most desirable epoxy-resin finish for each application. Confirmation of laboratory tests by field exposure makes it possible to choose finishes of the proper type.

The Packometer — An Electrical Approach to Paperwork Simplification..................58—PET-25

By H. A. Larberg, Panhandle Eastern Pipe Line Company, Kansas City, Mo. 1958 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1959).

Gas delivery rates are not constant and vary greatly from one day to the next. In fact, customers' demands vary considerably from one hour to the next.

The majority of the gas-transmission companies assure their customers a minimum amount of fuel by using the pipeline itself as a storage volume. Since gas is compressible, it is possible to store relatively large quantities in small containers.

The amount of gas contained in a flowing transmission line is commonly called "line pack." This mass of gas becomes an equalizing factor allowing a pipeline to be operated in a fairly constant fashion.

Although in the operation of a pipeline, it is necessary to know the correct amount of gas stored in the system, the daily change in pack is of more importance. A definite level of pack must be maintained for correct operation of a pipeline. Obviously, continuous knowledge of the pack condition in each section of the pipeline is necessary.

The "Packometer" is a simple electrical analog computer designed to determine the actual line pack and the differential of pack when it is changing. Its design and operation are described in this paper.

Survey of Mathematical Methods for Nonlinear Control Systems, by Julien M. Loeb. (57—A-104)

Development of the Generalized Phase-Diagram Method, by P. M. LeFévre. (57—A-216)

On-Off Control With Periodic Sensing Device, by Keisuke Izawa. (57—A-207)

Investigation of Erosion and Corrosion of Turbine Materials in Wet Oxygenated Steam, by H. A. Cataldi, C. F. Cheng, and V. S. Musick. (57—A-134)

On the Economics of the Basic Turning Operation, by R. C. Brewer. (57—A-58)

Oil-Whip Resonance, by E. H. Hull. (57—A-169)

Theory of Oil Whip for Vertical Rotors Supported by Plain Journal Bearings, by Finn Ørbeck. (57—A-171)

Static and Dynamic Characteristics of Compensated Gas Bearings, by H. H. Richardson. (57—A-138)

Solution of the Tapered-Land Sector Thrust Bearings, by O. Pinkus. (57—A-152)

"DeCew Falls, Abitibi" Turbine Tests, by A. E. Aeberli and R. A. Walker. (57—A-57)

Symposium on Laboratory Testing of Hydraulic Turbine Models in Relation to Field Performance. (57—A-124)

The Effect of Wakes on the Transient Pressure and Velocity Distributions in Turbomachines, by R. X. Meyer. (57—A-83)

Possible Similarity Solutions of the Laminar, Incompressible, Boundary-Layer Equations, by A. G. Hansen. (57—A-79)

One-Way Surge Tanks for Pumping Plants, by John Parmakian. (57—A-25)

Contribution to the Stability Theory of Systems of Surge Tanks, by Charles Jaegar. (57—A-65)

Water Hammer in Nonuniform Pipes as an Example of Wave Propagation in Gradually Varying Media, by H. M. Paynter and F. D. Ezekiel. (57—A-107)

Technical Briefs

Effective and Local Surface Coefficients in Fin Systems, by G. M. Dusinberre

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Includes Letters from Readers on Miscellaneous Subjects

COMMENTS ON PAPERS

Management and the World Struggle

To the Editor:

Your leading article, "Management and the World Struggle," by F. R. Barnett, in the August, 1958, issue of Mechanical Engineering, pp. 50–51, impresses one so strongly as of urgent timeliness in the national interest, as well as of exceptional readableness and literary value, that it should be placed before the general reading public as widely and as promptly as at all possible.

E. Burnely Powell.[1]

To the Editor:

..."Both you and the author of the address, 'Management and the World Struggle,' by F. R. Barnett, deserve the great thanks of the membership. This is a subject which bears constant repetition particularly when so ably presented.

"We Americans have the habit of relapsing into complacency after every emergency, such as the advent of the Sputniks. We fail to sense the actual intentions of the enemy we face, as so clearly portrayed by the author.

"This address deserves wide dissemination on account of its conciseness and its brevity, which attract many readers who might consider themselves too busy to read a longer dissertation. Our people must not only be awakened, but be kept awake to the dangers confronting us.

"The Society could do no greater service than to awaken not only the profession, but the entire nation."

Carroll D. Billmyer.[2]

To the Editor:

..."In my opinion, this is the finest, most direct appraisal of our current position in the most important battle that our nation and the free world have ever faced. It sweeps aside the cobwebs of theory and idealism to expose the naked facts.

"If only more people would realize the terrific portent of his final paragraph. Unfortunately, America seems to be coming rapidly bankrupt in two categories, that of forthright leadership and the ultimate weapon named by Mr. Barnett—human courage. I would prefer to use the more basic terminology, plain guts."

Robert D. Oldfield.[3]

To the Editor:

..."For one, I am glad to see an article such as 'Management and the World Struggle' in our magazine! What Mr. Barnett says needs to be said over and over again to get us out of this common-man equality-guilt cult."

E. A. Cyrol.[4]

[1] ASME Medalist, 1954; retired consulting engineer, Stone and Webster Engineering Corporation, Boston, Mass. Fellow ASME.

[2] Professional engineer, Kingston, R. I. Mem. ASME.

[3] Sales engineer and member of the board, Ohio Screw Products Company, Elyria, Ohio. Assoc. Mem. ASME.

[4] President, E. A. Cyrol & Company, Management Consultants, Chicago, Ill. Mem. ASME.

Training for the Future

To the Editor:

I have read with much interest the article, "Training for the Future," by James C. Zeder, which appears in the September issue of Mechanical Engineering, pp. 48–50. This is a timely subject and in my opinion, was extremely well presented. It indicates the trends in engineering education and also points out some of the problems.

Of particular interest to me was that part which appears on page 50 under the shoulder heading, "Engineering Education in the Future." We at International Correspondence Schools realize our responsibility in co-operation with resident-technical schools and with industry in order to provide complete training. We do not compete with resident-technical schools. We supplement their programs when it is impractical or impossible for them to meet a situation. Now that the colleges are placing even more emphasis on fundamentals for research and development, our training is even more urgently needed to provide specific instruction.

William N. Richards.[7]

[7] Assistant to the Dean of the Faculty, and Head of the School of Mechanical Engineering, International Correspondence Schools, Scranton, Pa. Mem. ASME.

The Spring Back of Coil Springs

Comment by S. M. Rimmer[5]

The problem of selecting proper arbor sizes for making coil springs of a specified diameter is one which springmakers have depended on experience and past records to solve.

Before comparing the authors' data in this paper[6] with our empirical results, we would like to point out that these data apply only to nonheat treated springs; stress relief will change the spring diameter in ways not always expected. For example, music wire springs will close down on heat treatment and stainless steel springs open up. Also, spring index generally refers to the pitch diameter over the wire diameter, and not the spring OD over wire diameter as used by the authors.

Our data based on winding springs on an arbor have been compiled and we find

[5] Spring works manager, Wallace Barnes Company, Bristol, Conn. Mem. ASME.

[6] F. J. Gardiner and H. C. R. Carlson, "The Spring Back of Coil Springs," Mechanical Engineering vol. 80, April, 1958, pp. 74–76.

this information agrees very closely with the results determined by using the authors' calculated procedure. This information having been recorded and expressed as the ratio of arbor size to spring ID is plotted against spring index. Surprisingly enough this record indicates the same straight line for most common spring material yields even annealed spring material yields.

The spring back is a measure of the ratio of the yield point and the ultimate strength, and these appear to go together for most cases. At low indexes, the materials are so severely strained that the discrepancies between various materials and strength levels are slight. At high indexes, however, there is an appreciable difference between spring materials which acquire their hardness by cold work (music wire) and those which acquire their hardness by heat treatment (oil tempered wire). In the case of the latter, the yield tensile ratio is higher, and more spring back may be expected. Our records based on experimental data must allow for this.

Calculations for music wire springs based on this chart and on the authors' data are as follows:

Wire Size	Index	Arbor size (Gardner & Carlson)	Arbor size Wallace Barnes Co.
0.010	5.25	0.037	0.038
0.010	20.8	0.129	0.134
0.030	3.17	0.061	0.061
0.030	19.8	0.395	0.388
0.125	3	0.239	0.234
0.125	15	1.39	1.33

Comment by M. G. Fangemann[8]

The authors of this paper[6] have derived a relation between the outside diameter of a helical coiled spring (D_s) and the outside diameter of the arbor (D_a) on which the spring is wound. As a result of their tests, they state that the average error in determining the arbor size by this formula is less than 2 per cent. (It is assumed that the error stated is a bilateral one, namely ±2 per cent.)

A question which follows naturally is whether an arbor, having a diametral error of ±2 per cent will produce a spring having a specified outside diameter within the usual commercial tolerances. (The Spring Manufacturer's Association has published a chart which gives the coil diameter tolerance for commercial springs.) By differentiating the authors' formula:

$$\frac{D_a}{d} = \frac{1.02}{\dfrac{1}{\dfrac{D_s}{d} - 1} + 1.85\dfrac{S}{E}} - 1 \quad (1)$$

[8] General Manager, Spring Division, John Chatillon & Sons, N. Y. C. Mem. ASME.

We get:

$$\Delta D_s = \frac{\dfrac{dE}{1.85\,S} - d + D_s}{\dfrac{1.02\,dE}{1.85\,S} - d - D_a}\,\Delta D_a \quad (2)$$

where

D_a = outside diameter of arbor, in.
D_s = outside diameter of spring, in. (in free position)
ΔD_a and ΔD_s = differential increments of D_a and D_s, respectively
d = wire diameter, in.
E = modulus of elasticity in tension, psi (of spring material)
S = ultimate strength, psi (of spring material)

In this expression ΔD_a can be considered to be the error in the arbor diameter D_a, then ΔD_s would be the error in the outside diameter D_s of the spring due to the error ΔD_a.

Assuming a spring of music wire having the values

D_s = 0.500 in.
d = 0.020 in.
$E = 30 \times 10^6$
S = 370,000 psi

D_a is calculated from formula 1 and equals 0.296 in. The average error ΔD_a is therefore ±0.02 D_a = ±0.0059 in. When this value is substituted in equation 2, the error ΔD_s = ±0.013 in. so that the value of D_s = 0.500 in. ± 0.013 in.

Referring to the afore-mentioned SMA chart on tolerances, a commercial spring would have an outside diameter of 0.500 in. ± 0.019 in.

As another example, assume that the spring is made of 0.080-in-diam wire instead of 0.020 in. In this case, the arbor size is 0.310 in. which will produce a spring having an outside diameter of 0.500 in. ± 0.007 in (S for 0.080 in. wire is 299,000 psi). The SMA chart yields the outside diameter as 0.500 in. ± 0.009 in.

In both examples, it is seen that the outside diameters calculated from the formula are well within the tolerances normally encountered in commercial practice.

The authors should be commended highly for the informative, useful data contained in this paper. The tables will be welcomed by all spring makers since the guess work of trial and error can, at last, be discontinued.

Comment by B. W. Shaffer[9]

The authors are to be congratulated for their attempt to provide the design engineer with a method for determining the arbor diameter required to obtain a spring of specified diameter.

The test data presented in the paper show relatively good agreement between computed and experimental results. Nevertheless, the discusser wishes to sound a note of caution on the use of the authors' method for coil springs having wire diameter larger than that tested and discussed in the paper. His point of view arises from the limitations that exist in the theory upon which the present paper is based.

It was assumed in the authors' theoretical development that the neutral and the centroidal axes coincide and that unloading occurs in an entirely elastic manner. Relatively recent studies of the behavior of sheet metal within the plastic range show that the two previous assumptions are not valid. In particular, Hill [1][10] and Lubahn and Sachs [2] showed that in plastic bending the neutral and centroidal axes do not coincide; Shaffer and House [3] discussed the movement of the neutral axis during elastic-plastic bending. Furthermore, Shaffer and Ungar [4] recently showed that unloading is accompanied by a plastic zone.

Since the distance between the neutral and centroidal axes as well as the size of the plastic zone becomes relatively smaller as the metal thickness decreases [3, 4], their effect may be sufficiently small for thin materials so that the authors' approximate theory can provide reasonable results even though they may not be entirely theoretically correct.

The afore-mentioned studies were conducted for specimens having rectangular cross sections. Nevertheless, similar results may carry over for bars having circular cross sections.

References

1 R. Hill, "The Mathematical Theory of Plasticity," Oxford University Press, London, England, 1950, pp. 287–289.

2 J. D. Lubahn and G. Sachs, "Bending of an Ideal Plastic Metal," *Trans. ASME*, vol. 72, 1950, pp. 201–208.

3 Bernard W. Shaffer and Raymond N. House, Jr., "The Elastic-Plastic Stress Distribution Within a Wide Curved Bar Subjected to Pure Bending," *Journal of Applied Mechanics*, vol. 22, *Trans. ASME*, vol. 77, 1955, pp. 305–310.

4 Bernard W. Shaffer and Eric E. Ungar, "Residual Stresses and Displacements in Wide

[9] Professor of mechanical engineering, New York University, University Heights, N. Y. Mem. ASME.

[10] Numbers in brackets designate References at end of this comment.

Curved Bars Subject to Pure Bending," N. Y. U. Technical Report prepared for the Office of Ordnance Research, Department of the Army under Contract No. DA-30-069-ORD-1398 in July, 1957.

Authors' Closure

The results shown by S. M. Rimmer are gratifying. They show an average error of 2 per cent and a maximum error of 4 per cent, exactly as experienced by the authors. The authors hope that Mr. Rimmer will be able to extend Fig. 3 with additional data.

The comment by M. G. Fangemann is interesting and had not been previously investigated; however, the authors believe that the error in finish spring OD is almost exclusively due to material variation from the data used in computing arbor size. Arbors can certainly be made to much greater precision than ±2 per cent. The authors believe that the error statement in the paragraph entitled "Tests" above is somewhat misleading. It should read "The average error in OD of springs made on arbors calculated in accordance with the above recommendations is less than ±2 per cent and never greater than ±4 per cent." It is assumed here that arbors are made to less than 0.2 per cent error.

The comment by Professor Shaffer is unfortunate. The authors have shown that a simple empirical spring-back law exists covering a wide range of geometries and materials—no theoretical justification is needed or necessary. In fact, the elementary theory does not agree with the facts and the complete theory is apparently sufficiently complicated to prohibit use. Fortunately, nature is not so unkind and a simple empirical law works—the theory notwithstanding.

Harold C. R. Carlson.[11]
Frank J. Gardiner.[12]

Equipment for Stationary Gas Turbines

Comment by J. W. Blake[13]

The authors have presented an excellent paper[14] on the equipment for stationary gas-turbine installations. They have modestly refrained from any reference to the most important component of such a project, namely, the gas-turbine unit itself. Speaking for my company, The Oklahoma Gas and Electric Company, I wish to point out that the two 4000-kw simple cycle gas-burning units, manufactured by their company and installed at our Belle Isle Station in Oklahoma City, have established an outstanding record as to performance, maintained economy, availability, and low-maintenance costs. The first of these units went into service in 1949, and the second in 1952. They were originally used for base load service and currently for peaking and stand-by. These are certainly extremes, and both units have proved their quality of design and construction. The older unit now has over 38,000 service hours, a pretty good score in any "Gas Turbine League."

Building noise level tests on our units verify readings given by the authors. Our 2-unit gas-turbine building is steel framed with Mahon siding for the first unit and corrugated transite for the second unit, with precast slab roof and bare concrete floor. Approximately 50 per cent of wall area is windows. No special acoustic treatment was given any part of the building.

Readings inside show 93.0 to 101.0 db and outside readings showed:

6 ft from building, on all sides 72.0 to 79.5 db
50 ft from building, on all sides 66.0 to 75.0 db
100 ft from building, on all sides 62.5 to 70.5 db

As might be expected from these readings, inside noise is bad, however, not objectionable since no operator is stationed therein. Outside noise is no more intense than is found outside any of our steam plants.

As to inlet ducts, filters, and precoolers, our practice has differed somewhat from that suggested by the authors.

Our inlet ducts were made from 10-gage steel plate, insulated, and supported by spring hangers from building steel. A plate-type inlet silencer is supported by duct and connected by sheet-rubber expansion joint to compressor inlet. Turning vanes are provided in elbows. This construction has been entirely satisfactory.

We have not used inlet filters. They were considered, but were not believed economically justified. Practice has proved this decision to be correct, since having the units down 24 hours for compressor cleaning each six months of operation has taken care of the dirt problem. A factor in our good experience without filters may be our use of precoolers. We agree with the authors that in hot climates a precooler is a must for gas turbines.

Our latest studies indicate the most economical precooler is an induced-draft cooling-tower type, using compressor as the air-moving device. Use of this type on our second unit has proved its simplicity and ability to deliver cool, clean air, free from entrained water, coupled with lower first cost and maintenance costs.

Our older unit has a finned-tube type of precooler, supplied with 65 F well water. Performance is better than either cooling-tower or air-washer types, but first cost cannot be justified.

We have found the most favorable type of expansion joint for connecting turbine exhaust to ducts to be a clearance-telescopic type with venturi inner liner. In service, such a joint, in addition to relieving the turbine-exhaust nozzle of all external loads, tends to induce atmospheric air into the gas stream, rather than permit the escape of hot flue gas. An outer sheet-metal cover retaining asbestos cloth and glass wool, controls air influx in operation, as well as taking care of the hot gas condition encountered in starting, before the full-speed gas flow has been established.

We have not used exhaust silencers, although the feedwater recuperators probably have some silencing effect. In the same category, one of our units is equipped with a 122-ft high stack while the second unit has one only 34-ft high. Both are located on the opposite side of the building from the air intakes. No flue gas-inlet air recirculation trouble has been experienced. We did find that oil-system vents must be placed well away from and out of air streams to compressor air inlets. Failure to respect this precaution was found to quickly foul the compressor blading. No objectionable noise conditions have resulted from either of these arrangements.

[11] Consulting engineer, The Carlson Company, Oceanside, L. I., N. Y. Fellow ASME.
[12] Manager, Engineering Products Section, Special Products Division, I-T-E Circuit Breaker Company, Philadelphia, Pa.
[13] Superintendent of generation, Oklahoma Gas & Electric Company, Oklahoma City, Okla. Mem. ASME.
[14] D. L. E. Jacobs and I. H. Landes, "Equipment for the Stationary Gas Turbine," Mechanical Engineering, vol. 80, July, 1958, pp. 45–51.

Use of Nondestructive Testing on Steel Castings for Elevated Temperature Service

Comment by Herbert R. Isenburger[15]

It is always heartening for a pioneer to see that good use is being made of a method which he helped to develop. I have reference to the author's apt description of the application of radio-

[15] President, St. John X-Ray Laboratory, Califon, N. J. Mem. ASME.

graphic inspection shown in his paper.[16]

But it is just as sad to find one's pet technique described with credit given to someone else. This refers to the double-exposure technique first developed by the writer in the late 1920's. It was described in the *Iron Trade Review*, Feb. 6, 1930, and in *Machinery*, February, 1930. A more detailed description including an application of thickness determination was published in our book on Industrial Radiography, Wiley, 1934. The author's reference [9] would indicate that the Eastman Kodak Company suggested this technique originally in their publication on Radiography in Modern Industry, 1947. While our technique has been described in detail, no direct credit is given except that Kodak mentions our book in the general bibliography.

While the location of a defect can thus be calculated, this is not always necessary. It is often sufficient to know from which side a casting repair should be made. This can be determined by an experienced radiographer while the film is still washing. In that way time can be saved. On other occasions, as in the case cited in our afore-mentioned literature, no repair is necessary if the defect, in this case a large sand pocket, is located toward the outer surface of the casting with plenty of sound metal between the inner surface where the high-pressure, high-temperature steam might have started damage.

[16] C. B. Jenni, "The Use of Nondestructive Testing on Steel Castings for Elevated Temperature Service," MECHANICAL ENGINEERING, vol. 80, April, 1958, pp. 66–70.

Author's Closure

The use of the double exposure method of depth determination was cited as a tool which can at times be used to advantage. The reference used, namely, "Radiography in Modern Industry," by Eastman Kodak Company, was cited since this volume is usually found on the shelves of the most radiographers and would thus be widely available in case any more details were desired. There was no intent to develop the historical development of the method.

Clyde B. Jenni.[17]

[17] Chief metallurgist, General Steel Casting Corp., Eddystone, Pa. Mem. ASME.

BOOKS RECEIVED IN LIBRARY

Oral Communication of Technical Information

By Robert S. Casey. 1958, Reinhold Publishing Corp., New York, N. Y. 199 p., $5^1/_4 \times 7^1/_2$ in., bound. $4.50. Written to provide a practical guide to effective speaking for technical personnel. The book covers organization of material, composition, delivery of formal and impromptu speeches, and the use of mechanical aids such as recordings and slides. In addition special sections are devoted to presiding at meetings, presenting science to the layman, and giving technical legal testimony.

Organization and Management in Industry and Business

By William B. Cornell. Fourth Edition revised and rewritten by Huxley Madeheim. 1958, The Ronald Press Company, New York, N. Y. 579 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. The fundamental principles and practices in the organization, management, and operation of a business or industrial enterprise. The first part of the volume traces the development of an organization from its original concept to full-scale operation, while the second deals with all the phases and operations concerned with the manufacturing of products. The final part discusses marketing, finance, and administration. In this edition a new chapter has been added on automation and linear programming.

Pump Operation and Maintenance

By Tyler G. Hicks. 1958, McGraw-Hill Book Co., Inc., New York, N. Y. 310 p., $6^1/_4 \times 9^1/_4$ in., bound. $9. Covers the operation and maintenance of pumps used in many industries. Specific data are provided on installing, starting up, routine operation, periodic maintenance, and major overhaul, along with such recent advances as the barrel and process-type centrifugal pump, sanitary pump for food handling, and developments in pump-shaft metallizing.

Register of Dams in the United States

Compiled and edited by T. W. Mermel. 1958, McGraw-Hill Book Co., New York, N. Y. 429 p., $8^1/_2 \times 11^1/_4$ in., bound. $12.50. In anticipation of the holding of the next International Congress on Large Dams in the U. S., this extensive compilation has been prepared, presenting essential statistics on over 2800 important dams in the U. S.—completed, under construction, and proposed. The main part of the book is an alphabetical listing of the dams, giving location, structural data, reservoir capacity, ownership, by whom the engineering was performed, and the construction contractors. Additional data: A section containing photographs of over 300 dams; lists of the 100 highest and 100 largest dams, and of the 100 largest reservoirs; an alphabetical list of reservoir names; and a summary of the laws of all 48 states dealing with the supervision and control of dams. The book is sponsored by the United States Committee of the International Commission on Large Dams.

Symposium on Steam Turbine Oils

Published 1957 as Special Technical Publication No. 211 by the American Society for Testing Materials, Philadelphia, Pa. 106 p., $6^1/_4 \times 9^1/_4$ in., bound. $3. The trend toward higher steam temperature and pressure has increased the hazards and problems in turbine systems. The papers included here deal with such topics as fire-resistant turbine fluids, antiwear properties of oil, load-carrying ability, rust-inhibition, and oil life. The final paper discusses the evaluation and performance of turbine oils.

V D I Berichte

Bd. 10: Werkstoff-Fragen für den Konstrukteur.; Bd. 24; Schwingungsabwehr.; Bd. 25: Fahrzeugtechnik.

Published 1957 by the VDI-Verlag, Düsseldorf, Germany. 83, 153, 102 pp., $8^1/_4 \times 11^3/_4$ in., paper. 16.80, 28.80, 20.80 DM. Three additional issues in this series of published papers from technical sessions of the VDI. No. 10: Discussions of design problems with respect to materials: creep and fatigue, strength of metals; characteristics of plastics; residual stresses; etc.

No. 24: Twenty-six papers on vibration control covering a wide range: turbine blades, electrical machinery, foundations, railroads, motor vehicles, noise control, and physiological aspects.

No. 25: A symposium on "adaptation of vehicles to human beings." Topics include the physiological effects of noise, vibration effects, exhaust-gas control, and various aspects of the design of seats and compartments for comfort, fatigue reduction, and accident avoidance.

Vibration and Impact

By Ralph Burton. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 310 p., $6^1/_4 \times 9^1/_4$ in., bound. $8.50. An introductory treatment of vibrations and of oscillatory phenomena in general that bridges the gap between introductory dynamics and advanced fields of engineering analysis. Free vibration, damping, impact, steady forced as well as nonlinear vibration, systems with two degrees of freedom and with many degrees of freedom, waves, vibrating beams, and fatigue are discussed. Problems are directed toward the application of theory to practical situations.

Zahnräder

Vol. II: Stirn und Kegelräder mit schrägen Zähnen; Schraubgetriebe. By A. Scheibel. Fourth Edition revised by W. Lindner. 1957, Springer-Verlag, Berlin, Germany. 132 p., $7^1/_2 \times 10^1/_2$ in., paper. DM 21. This second volume of a treatise on gear design contains three main sections. The first section deals with spur and bevel gears having helical teeth; the second, with worm gears; the third provides a brief treatment of the measurement of gear characteristics. This new edition considers the developments of the past 20 years and the standards introduced in that period.

ASTM Standards on Iron Castings

Published 1957 by the American Society for Testing Materials, Philadelphia, Pa. 158 p., 6×9 in., paper. $2.75. Brings together standards and tentative methods of test as well as specifications relating to iron castings. Includes information on pig iron, gray iron castings, cast-iron pipe, nodular iron castings, malleable iron castings, and welding rods and electrodes.

Air Conditioning and Refrigeration

By William H. Severns and Julian R. Fellows. 1958, John Wiley & Sons, Inc., New York, N. Y. 563 p., $6^1/_4 \times 9^1/_4$ in., bound. $10.25. Based on the second edition of the authors' "Heating, Ventilating, and Air Conditioning

Fundamentals," this volume has been considerably rewritten, and in addition contains as added chapter on fluid flow. Emphasis is placed on practical application and problems are included involving the design of an air washer, of hot-water heating systems, fan-duct systems, and all-year air-conditioning systems.

Air Pollution

Edited by M. W. Thring. 1957, Butterworths Scientific Publications Ltd., London, England; Butterworth & Co. (Canada) Ltd., Toronto, Ont. 248 p., $5^1/_2 \times 8^3/_4$ in., bound. $8.50. Aspects dealt with include the character and consequences of air pollution; dispersion of discharged gases; legislation; elimination of pollution caused by domestic heating, vehicle-exhaust fumes, and industrial boilers and equipment. The book is based on papers given at a conference at the University of Sheffield, September, 1956.

Airplane Design Manual

By Frederick K. Teichmann. Fourth Edition, 1958, Pitman Publishing Corp., New York, N. Y. 489 p., $6^1/_4 \times 9^1/_4$ in., bound. $8.50. A guide to the practical aspects of airplane design. Information is provided on the principles of aerodynamics, structural design, installation requirements, and the application of materials. In addition there are data on the economics of design, performance calculations, and allied problems. In this revised edition greater emphasis is placed on the analytical approach to design problems.

Applied Statistics for Engineers

By William Volk. 1958, McGraw-Hill Book Co., Inc., New York, N. Y. 354 p., $6^1/_4 \times 9^1/_4$ in., bound. $9.50. Concerned with the treatment of engineering data for correlation, precision, and analysis of experimental factors. It emphasizes engineering applications rather than theory and provides a number of illustrative examples. A review of probability theory and frequency distribution is included as are detailed discussions of curvilinear correlation, the analysis of variance, and the interpretation of the analysis of variance.

Difference Methods for Initial-Value Problems

By Robert D. Richtmyer. 1957, Interscience Publishers, Inc., New York, N. Y. 238 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. Discusses finite-difference methods for the approximate numerical solution of initial-value problems arising in various branches of continuum physics. Part one is a general discussion of these methods for linear problems in terms of the theory of linear operators. Part two contains descriptions of the principal finite-difference methods currently in use by automatic digital computers.

The Effects of Radiation on Materials

Edited by J. J. Harwood and others. 1958, Reinhold Publishing Corp., New York, N. Y. 355 p., $6^1/_4 \times 9^1/_4$ in., bound. $10.50. Theories and concepts of radiation effects, radiation sources, and measurements of radiation are presented, as are the known effects of radiation on the physical, metallurgical, mechanical, corrosion, and electrical properties of materials. Among the materials dealt with are metals, alloys, inorganic dielectrics, semiconductors, organic and polymeric materials, and materials for nuclear reactor components. Comprises papers delivered at the Colloquium on the Effects of Radiation on Materials at The Johns Hopkins University in 1957.

Ergebnisse der Hochvakuumtechnik und der Physik Dünner Schichten

Edited by M. Auwärter. 1957, Wissenschaftliche Verlagsgesellschaft, Stuttgart, Germany. 282 p., $6^1/_2 \times 9^1/_2$ in., bound. 52 DM. A group of papers dealing with high-vacuum technology and with the physics of thin layers, subjects of interest to engineers in many fields. Sample topics are the following: Technical problems in vacuum production for mercury rectifiers; changes in material properties of thin layers during the evaporation process; measurement of the thickness of a layer with the aid of an optical interference filter; structure and growth of thin vapor-deposited fluoride layers.

LIBRARY SERVICES

Engineering Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Fluid Mechanics

By Victor L. Streeter. Second Edition. 1958, McGraw-Hill Book Co., Inc., New York, N. Y. 480 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.50. Beginning with the fundamental equations and concepts of fluid mechanics, the book continues with their applications to flow measurement, hydraulic machinery, pipe systems, and open-channel flow. The principles of control systems and oil hydraulics are also discussed. This edition has been extensively revised to include new material on fluid properties, dimensional analysis and dynamic similitude, compressible flow, and negative surge wave treatment.

Fluid Pressure Mechanisms

By H. G. Conway. Second Edition. 1958, Sir Isaac Pitman and Sons, Ltd., London, England. 235 p., $5^1/_2 \times 8^3/_4$ in., bound. 32s. 6d. Studies the mechanism of hydraulic and pneumatic machinery, particularly from the viewpoint of their essential principles. Among the changes made in this edition are the inclusion of new material on slide valves, jacks with force limitation, special couplings, and synchronization systems. The chapter on servo systems has been substantially revised.

Gmelins Handbuch der Anorganischen Chemie

Eighth Edition. Verlag Chemie, Weinheim/Bergstrasse, Germany. System Nr. 28: Calcium, Teil B, Lieferung 2. 1957. 656 p., 7×10 in., paper. 219 DM ($52.56). System Nr. 60: Kupfer, Teil B, Lieferung 1. 1958. 624 p., 7×10 in., paper. 349 DM ($83.76). This exhaustive review of the chemical and metallurgical literature provides a compilation of technical data on the respective elements and their compounds, as well as references to the sources from which the information came. Of the current issues, "Calcium" covers Ca compounds with H, O, N, F, Cl, Br, I, and S. "Copper" covers Cu compounds with the same eight elements, and with Se and Te as well. For each compound data are given for structure, chemical and physical properties, thermodynamic characteristics, and other pertinent information, graphs and tables being utilized where a series of figures is available. The literature reference is cited immediately after each item of the included data.

A Growth Survey of the Atomic Industry, 1958–1968

By Frederick H. Warren and others. 1958, Atomic Industrial Forum, Inc., New York, N. Y. 84 p., $9 \times 11^1/_2$ in., spiral binding. $25. Examines the business potentials of the nuclear industry based on the experience of large commercial power plants. The programs for nuclear development in Europe are also considered in relation to the effect that these programs would have on the nuclear industry in the United States. In addition, such aspects as fuel and fuel-processing requirements, reactor components, and military programs are investigated.

A Handbook of Lattice Spacings and Structures of Metals and Alloys

By W. B. Pearson. 1958, Pergamon Press, New York, N. Y. 1044 p., $6^1/_4 \times 10$ in., bound. $38. A reference work on the structures and lattice spacings of binary and ternary alloys. Part one is a general introduction to the x-ray investigation of metals and alloys with emphasis on the use of structure determination and lattice spacing measurements to provide information on the physical state of metals and alloys, particularly equilibrium diagram determination. Part two is a compilation and assessment of published x-ray work on metals and alloys in equilibrium with alloy systems listed in alphabetical order.

High-Speed Data Processing

By C. C. Gotlieb and J. N. P. Hume. 1958, McGraw-Hill Book Co., Inc., New York, N. Y. 338 p., $6^1/_4 \times 9^1/_4$ in., bound. $9.50. Covers high-speed data processors of all types and all manufacturers. There is a detailed study of coding and programming with special emphasis on the value of flow charts in the analysis of problems. A variety of examples and illustrations are given for typical applications in the major fields. Recent aspects are discussed such as over-all reliability and checking of results, use of large random-access stores, and form of files.

History of the British Iron and Steel Industry

By. H. R. Schubert. 1957, Routledge and Kegan Paul, London, England; U. S. distributor, The Macmillan Co., New York, N. Y. 445 p., $6^1/_2 \times 10$ in., bound. $12. A comprehensive study covering the period from prehistoric times to 1775 when the British iron and steel industry had completed its transition to coke as against the use of charcoal up to that time. The account of the development of the industry is divided into two parts, the first dealing with direct extraction of malleable iron from ore and the second with the production of cast or pig iron in blast furnaces. The book is well-illustrated and documented.

Integral Equations and Their Applications to Certain Problems in Mechanics, Mathematical Physics, and Technology

By S. G. Mikhlin. 1957, Pergamon Press, New York, N. Y. 338 p., $5^3/_4 \times 8^1/_2$ in., bound. $12.50. An advanced text divided into two parts. The first part deals with the fundamentals of integral equations, while the second and larger part is given over to practical applications involving one-dimensional and two-dimensional problems such as the statical theory of elasticity, immersed bodies

in hydrodynamics, and the theory of oscillations.

Man, Metals and Modern Magic
By J. Gordon Parr. 1958, published jointly by the American Society for Metals, Cleveland, Ohio, and the Iowa State College Press, Ames, Iowa. 238 p., $5^1/_4 \times 7^3/_4$ in., bound. $2.95. A history of the role that metals have played in the development of civilization. Beginning in 6000 B.C. and continuing down to the present, the author traces the use of bronze and iron, the development of alloys, the expansion of nonferrous metallurgy, and the metallurgy of nuclear fission.

Managing Geographically Decentralized Companies
By George A. Smith, Jr. 1958, Harvard Business School, Division of Research, Soldiers Field, Boston, Mass. 185 p., $5^1/_2 \times 8^1/_2$ in., bound. $3.50. An analysis of the clinical histories of decentralized firms and of their organizational problems and experiences. Varied organizational patterns and managerial arrangements are studied, while the experiences of companies with alternative approaches to similar problems are also presented and analyzed.

Metals
Published 1958 as Special Technical Publication No. 196 by the American Society for Testing Materials, Philadelphia, Pa. 175 p., $6^1/_4 \times 9^1/_4$ in., bound. $4.50. Twelve papers dealing with corrosion, fatigue, and strength properties of metals. Specifically, they cover shotpeening, effect of forming on properties, axial stress fatigue, and results of studies on steels, aluminum, magnesium, and beryllium copper.

Metals and Men
By D. M. LeBourdais. 1957, McClelland & Stewart, Ltd., Toronto, Canada. 416 p., $6^1/_4 \times 9^1/_2$ in., bound. $8.50. A record of the discovery and development of mines in Canada. The course of events is traced from its beginnings in the Cariboo district of British Columbia to the present developments in New Quebec and Labrador. The contributions of prospectors, promoters, geologists, metallurgists, engineers, and mine managers are explored in relation to the technical, geographical and economic problems encountered in this period.

Modern American Engineers
By Edna Yost. Revised Edition. 1958, J. B. Lippincott Co., Philadelphia, Pa. 182 p., $5^1/_2 \times 8^1/_4$ in., bound. $3. The 12 biographies included in this volume are intended as an inspiration and a stimulant to young people who are considering what career to pursue. Each man is presented as a person as well as a significant contributor to the technological field. The 12 men are picked from a wide range of activities including civil, mechanical, electrical, and mining engineering. In this new edition their careers have been brought up to date since the first edition of 1952.

Nuclear Reactor Experiments
By the Staff of Argonne National Laboratory. 1958, D. Van Nostrand Co., Inc., Princeton, N. J. 480 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.75. Problems relating to the design, construction, and operation of nuclear reactors are outlined with details of equipment and experiments. Areas included are nuclear radiation detection, moderator and subcritical assemblies, cross sections, operating reactors and their characteristics, heat removal from a reactor, corrosion and radiation effects, fuel preparation, and separation processes.

Notes on Analog-Digital Conversion Techniques
Edited by Alfred K. Susskind. 1958, John Wiley & Sons, Inc., New York, N. Y. Various pagings, $6 \times 9^1/_4$ in., bound. $10. Presents the subject matter in three parts. The first discusses systems aspects of digital information processing that influence the specifications for analog-to-digital and digital-to-analog conversion devices. In the second part a detailed engineering analysis and evaluation of a variety of conversion devices is presented. The third part is devoted to a case study based on development work done at the Servomechanisms Laboratory of the Massachusetts Institute of Technology. The book has been reprinted with corrections from the edition published by the M.I.T. Technology Press in 1957.

Ordinary Difference-Differential Equations
By Edmund Pinney. 1958, University of California Press, Berkeley, Calif. 262 p., $6^1/_4 \times 9^1/_2$ in., bound. $5. Provides practical techniques for dealing with difference-differential equations where provision is made for a time lag between past and present action. An introductory section indicates the nature and use of various methods of solution, and is followed by a detailed discussion of the infinite series solution as well as methods of finding the roots of the characteristic equation. The book also deals with first and second order mixed difference-differential equations. Techniques are applicable to design of guidance systems, prediction of business trends, and numerous engineering problems.

Petroleum Refinery Engineering
By W. L. Nelson. Fourth Edition. 1958, McGraw-Hill Book Co., Inc., New York, N. Y. 960 p., $6^1/_2 \times 9^1/_2$ in., bound. $15. Useful both as a text and as a handbook. It includes methods of processing petroleum, the design of refinery equipment, the evaluation of crude petroleum for the yield of products, the practical usefulness of petroleum products, and the cost of refinery equipment and its operation. Physical and thermal properties have now been revised to include jet fuels and rocket fuels. A new appendix analyzes over 70 foreign crude oils as well as about 90 representative U. S. oils for comparison.

Physics of Nuclear Fission
Translated from the Russian by J. E. S. Bradley. 1958, Pergamon Press, New York, N. Y. 182 p., $5^1/_2 \times 8^1/_2$ in., bound. $9. Originally published as a supplement to the Soviet Journal *Atomnaya Energiya*, this is a collection of papers revealing the status of Soviet research in nuclear fission as of 1956. Topics discussed include: fast neutron fission cross sections; charge and mass distribution of fission products; anisotropy in fission processes; fission neutrons; some features of nuclear fission at high and low-excitation energies; spontaneous fission of heavy nuclei; photofission.

Programming for an Automatic Digital Calculator
By Kathleen H. V. Booth. 1958, New York, Academic Press, Inc., New York, N. Y. 238 p., $5^3/_4 \times 8^3/_4$ in., bound. $7.50. Illustrates the processes of programming by reference to automatic digital computers now in use. Aspects dealt with include input and output, division and square root, nonarithmetic programs, matrix operations, simultaneous linear equations, mechanical translation, an interpretive program for decimal tapes, interpretive routines and pseudocodes, fault findings, and automatic programming.

Rheology: Theory and Applications
Vol. 2, Edited by Frederick R. Eirich. 1958, Academic Press, Inc., New York, N. Y. 591 p., $6^1/_4 \times 9^1/_4$ in., bound. $18. The present volume as contrasted with the first in this series is more specific. In addition to viscoelasticity, relaxation, and experimental methods, it covers applied theory and descriptive matter concerning substances in relation to these phenomena. Among those substances studied are organic glasses, raw elastomers, cellulose derivatives, gelatin, asphalts, and fibers.

Strain Gage Techniques
Lectures and Laboratory Exercises by W. M. Murray and P. K. Stein, presented at M.I.T., July, 1957. Distributed by the Society for Experimental Stress Analysis, Cambridge, Mass. 2 vols., $8^1/_2 \times 11$ in., paper. $13. A thorough review of strain-gage techniques which covers such aspects as: Mechanical and electrical aspects of the gage system; the potentiometer circuit; the Wheatstone Bridge; design of high-sensitivity circuits using galvanometers; common zero balancing; multiple gage bridge circuits; determination of amplifier characteristics; amplitude modulation; calibration of a strain indicating system; dynamic strain measurement; Rosette analysis. Detailed laboratory experiments are also explained.

A Management Guide to Electronic Computers
By William D. Bell. 1957, McGraw-Hill Book Co., Inc., New York, N. Y. 403 p., $6 \times 9^1/_4$ in., bound. $6.50. Addressed to executives who do not have an engineering background, this book discusses in nontechnical language the over-all electronic data processing system, components, programming, the present state of computer development, and questions of obsolescence, maintenance, cost, and system selection. A specific plan to assist a company interested in acquiring a system is outlined and the experiences with electronic equipment of eight companies are described.

ASTE Collected Papers 1957
Published, 1957, by American Society of Tool Engineers, Detroit, Mich. Various pagings, $8^1/_2 \times 11^1/_4$ in., loose-leaf binding. $10 The papers in this volume are grouped under the following headings: general interest, process engineering, tool design, cutting tools, plastic tooling, and standards. Altogether there are more than 40 papers on such subjects as chip breaking characteristics of titanium-power roll forming, cutting tool temperatures, etc. Two groups of papers represent the ceramic tool and plastic tooling symposiums.

ASTM Standards on Rubber Products
Published by the American Society for Testing Materials. 1957, Philadelphia, Pa. 826 p., 6×9 in., paper. $5.25. Among the topics covered in this compilation are automotive and aeronautical rubber; packing and gasket materials; electrical protective equipment; insulated wire and cable; latex foam; nonrigid plastics, and rubber adhesives. Of the more than 150 standards included, 32 are new or recently revised.

ASTM Standards on Thermal Insulating Materials
Published by the American Society for Testing Materials. 1957, Philadelphia, Pa. 208 p., 6×9 in., paper. $3. A special compilation of 55 specifications, methods of test, methods of sampling, recommended practices and lists of definitions covering insulating cement, batt and blanket, felt, block and board, and pipe insulation. A list of selected references is included.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

UNITED ENGINEERING CENTER FUND INCREASES

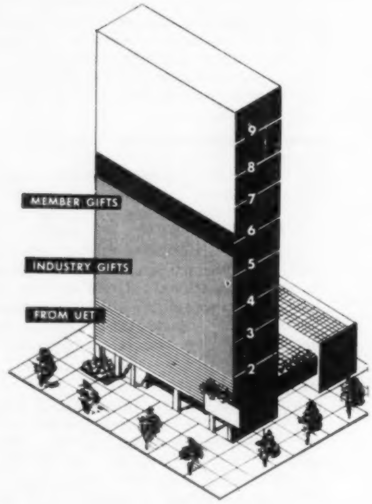
SEPTEMBER brought the ASME Member Gifts Campaign to new highs as individual Sections made great strides. Waterbury, Conn., became the first section to reach its objective, reporting a total of 105.3 per cent of quota at the end of the month. The Waterbury Section Member Gifts Committee, under the chairmanship of John D. Melville, reports efforts will continue until every member has been asked to give.

A special report early in October by Robert Plunkett, chairman of the Schenectady Member Gifts Committee, indicated that his Section had also exceeded its quota.

Other leaders were Atlanta, 89.3 per cent of quota; West Virginia, 77.5 per cent; Northwest Florida, 72.2 per cent; and Canton-Alliance-Massillon, 66.8 per cent. Of the 86 Sections of the Society, 59 had reported returns, leaving 27 not yet heard from.

Other Founder Societies also reported encouraging progress. Altogether, as this issue went to press, the five Founder Societies had reported gifts totalling $589,863, of the total quota of $3 million. Industry gifts at the same time totalled $3,612,733, of a total quota of $5 million. The remaining $2 million of the total cost of $10 million is available from current resources of United Engineering Trustees.

R. E. Dougherty, General Chairman of the Founder Societies Member Gifts Campaign, reported, on October 4, that over 20 per cent of the first half million dollars had been received during the month of September. He added, "October, November, and December are critical months. The planning and the organization that have been done and the leadership that has been mobilized should carry through this program on schedule."



Of the $10 million goal for construction of the new United Engineering Center funds available as of Sept. 1, 1958, are shown above

International Co-ordinating Committee on the Properties of Steam

DURING the past 30 years a total of five international conferences have been held on the properties of steam. The ASME has served as international secretariat for the conferences since 1954. In addition, through its Research Committee on the Properties of Steam (formerly the Research Committee on Steam Tables), ASME has co-ordinated and directed much of the steam research in this country[4] and has served as the United States Representative to the international conferences.

[1] Professor, department of chemical engineering, California Institute of Technology, Pasadena, Calif.

[2] Professor, department of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass. Mem. ASME.

[3] Professor and chairman, department of mechanical engineering, M.I.T., Cambridge, Mass. Executive Secretary of U. S. A. Commission on Properties of Steam. Fellow ASME.

[4] The current ASME program (covering research on steam viscosity, thermal diffusivity, Joule-Thomson coefficient, specific heat, and the relaxation rate of steam) totals nearly $375,000 over a three-year period.

At the last conference, which was held in London in the summer of 1956, arrangements were made for the formation of a small working group involving representatives from the USSR, United Kingdom, Germany, and the U.S.A. This working group has been called the International Co-ordinating Committee on the Properties of Steam. An informal meeting of the Committee was held in London, in July, 1957.

The first formal session of this Co-ordinating Committee was held in Moscow, July 21–22, 1958. It was attended by delegates from each of the member nations and, in addition, by a number of observers from each country represented. The meetings were held at the White Hall of the House of Scientists of the USSR Academy of Sciences.

Thermodynamic and Transport Properties of Steam

The first session of this Committee, which was concerned with the thermodynamic and transport properties of steam, reviewed the available experimental data and considered what additional facts were necessary to establish the thermodynamic properties of water in the liquid and gas phases with an accuracy at least commensurate with the requirements for the design of equipment utilizing water as a working fluid. In addition, the details of the form to be followed in the submission of experimental data, as well as the schedule of future meetings, were reviewed. The primary objective was the establishment of the necessary procedures to permit each of the interested nations to prepare a tabulation in skeleton form of the thermodynamic properties for consideration at the next international conference on the properties of steam.

The first matters considered by the Co-ordinating Committee at its Moscow meeting were the available data upon steam. The experimental information now available, or planned for submission in the near future, is summarized in Table 1, page 149.

UNITED ENGINEERING CENTER

Here is a current study of the new United Engineering Center. The present planning provides for a 20-story tower occupying 25 per cent of the plot area. This is the maximum allowed under New York City ordinances. In order to allow for free flow of traffic, the basement and the first two stories, which will occupy the full plot area, will be devoted to the Engineering Societies Library, conference rooms, engineering and scientific exhibits, cafeteria, storage, and centralized services. The general planning calls for the use of the tower for the offices of the individual societies. The estimated gross area will be about 280,000 sq ft and the net area usable as office space will be about 190,000 sq ft, the difference being used for necessary mechanical equipment, elevators and elevator lobbies, corridors, and shafts.

You Can Help

Every member of ASME can help assure the success of the Member Gifts Campaign, not only by making a personal gift but by helping to encourage others to give. If you would like to volunteer your services in the Member Gifts Campaign, call or write your Section Officers Campaign Chairman or your Section Officers.

With the active participation of many members, money for the new Center can be available by the end of this year.

Gifts From Abroad

In addition to gift campaigns organized through Sections, ASME has received contributions to date from 13 foreign countries including England, Holland, Philippines, Venezuela, Colombia, Spain, Belgian Congo, Belgium, Jamaica, the Netherlands, Germany, Australia, and Denmark.

Met in Moscow, July 21-22, 1958

Report by B. H. Sage,[1] F. G. Keyes,[2] and J. H. Keenan[3]

The obvious conclusion from a review of Table 1 is the preponderance of data which have been or are being accumulated by the scientists of the USSR. The Moscow Power Institute is carrying out an extensive series of investigations upon the pressure-volume-temperature relations of water, and their present work extends to pressures as high as 250 bars and temperatures as great as 650 C. Experimental work now under way or contemplated should yield information at pressures as high as 2000 bars and temperatures up to at least 1000 C. The University of California has completed work at pressures up to 1400 bars and temperatures up to 900 C. Further experimental work upon the volumetric behavior of water is under way in Canada, but detailed information concerning its progress was not available to the Committee.

It has been found most advantageous to make direct measurements of enthalpy as a function of state and several programs directed to this end are now under way. The Imperial College in the United Kingdom has been actively engaged in this work for several years and measurements at temperatures up to 750 C are expected to be completed in 1959, and they are planning to extend the work in the following year within this temperature interval to pressures up to 1000 bars. In addition, the United Kingdom submitted to the Committee previously unpublished enthalpy data at temperatures as high as 600 C. The Moscow Power Institute is contributing to the measurement of enthalpy as a function of state and they have published work yielding results at pressures up to 400 bars and 550 C and further studies are now under way. At the Siemens-Schuckert works in Germany, measurements at temperatures up to 800 C are planned for completion and publication by the end of 1960.

For a number of purposes, measurements of the deviation in the behavior of steam from a perfect gas are often of value. At the California Institute of Technology direct measurements of the local values of the Joule-Thomson coefficient and the rate of change of enthalpy with pressure under isothermal conditions are under investigation. Both of these studies are planned to reach a maximum pressure of 1000 bars and temperatures as high as 800 C. Measurements are now under way and the Joule-Thomson data should be available late in 1959 and the enthalpy measurements late in 1960.

There has been much interest in measurement of the isobaric specific heat in the USSR. A total of some five series of investigations has been completed or is in progress at the Moscow Power Institute, and a similar number of studies have been published, are under way, or are planned for future study at the All-Union Thermo-Technical Institute. These measurements in almost all cases involve flow calorimetric techniques.

It was recognized that isobaric heat capacities could be obtained from the Joule-Thomson and isothermal enthalpy-pressure coefficients being studied in the

United States, and it is also planned to carry out some direct measurements of the isobaric heat capacity at some future time.

Upon the completion of the heat-capacity measurements planned in the USSR, there should be a rather thorough coverage of the ranges of temperature and pressure of industrial interest to be used as auxiliary data in the preparation of the so-called "skeleton" steam tables. It should not be overlooked that some additional measurements of the isochoric heat capacities have been completed and published in the USSR in 1957.

On the whole, reasonable agreement appears to be realized in regard to the volumetric and thermal measurements which have been completed to date. However, it will remain for each of the interested groups to carry out detailed technical evaluations of the consistency agreement and accuracy of the numerous data available before it will be possible to assess the reliability and basic accuracy of the skeleton tables, which will be submitted to the sixth International Conference.

Some new transport data were submitted to the Committee. These included measurements by the All-Union Thermo-Technical Institute upon the thermal conductivity and viscosity of steam at elevated pressures and temperatures. Preliminary measurements upon viscosity were also made available by the United Kingdom and the U.S.A. As pointed out by the delegates from the USSR, there is still need for further experimental effort upon transport properties, as the agreement between data of different investigators is not particularly satisfactory. There appears in the study of both thermal conductivity and viscosity a need to reconcile data obtained with equipment involving different geometries used for the measurement of the transport of energy and momentum, respectively. There was little emphasis on the need for additional experimental work upon volumetric or thermal measurements during the deliberations of the Committee. Nearly all delegates agreed that further transport measurements were necessary before any unanimity of opinion as to the numerical values to ascribe to the thermal conductivity and viscosity of steam could be reached.

In order to permit the various groups to be able to assess the reliability, precision, and accuracy of the data to be submitted, some uniformity as to procedure and method of presentation was deemed desirable. With this need in view, the following agreements were reached concerning these matters:

I Resolution on Communication of Experimental Data to the International Secretariat

Preamble: Definitions

1 Instrument readings. When a complex experiment aiming at the determination of some thermodynamic quantity is performed, the set of measurements taken directly during one particular run will be called the set of *instrument* readings.

2 Corrected instrument readings. Readings taken on a set of instruments usually require corrections determined by *calibration*. When the corrections have been applied there results a set of *corrected instrument readings*. The corrections will be known as *calibration corrections*.

3 Averaged, corrected instrument readings. When measurements are made in steady-state, the instrument readings usually *fluctuate* in time and must be averaged. The averaging process may precede or follow the application of calibration corrections. The final result will be known as the set of *averaged, corrected instrument readings*.

4 Measured parameter. Evaluating equation. Experimental value (of measured parameter). In order to evaluate the final quantity to be measured, or the *measured parameter*, it is necessary to substitute the set of instrument readings into the *evaluating equation*. Depending on the individual conditions of the measurement the *corrected instrument readings* or the *averaged, corrected instrument readings* may be substituted. In either case a set of values of the *measured parameter* is obtained which reflects the fluctuation. This set is then *averaged*. The final result will be called the "*experimental value*."

The evaluating equation usually contains a *principal form* and *corrections*. The *experimental value* is deemed to have been *evaluated from the principal form* and *corrected* by the application of *all corrections*.

In order to signify whether or not this has been done, a distinction may be made between the *experimental value* and the *uncorrected experimental value*.

5 Smoothed values (of measured parameter). When in a series of measurements the *measured parameter* ranges over a set of states as described by the *independent parameters* the resulting curves, surfaces, and the like are not continuous or *smooth*. Smoothing may be performed graphically, by fitting empirical analytic expressions or by the more complex statistical procedures. In any case, the resulting values will be known as *the smoothed values*.

Since, as a rule, the *measured parameter*, Z, is a function of two independent parameters, X, Y, the results will be presented as

$$Z = Z(X) \text{ at } Y = \text{const}$$

Since measurement at $Y = \text{const}$ is rarely possible it will be necessary to *reduce* the data to a common value Y. A distinction may be made between *interpolated smoothed values* and *extrapolated smoothed values*.

6 Reproducibility. In order to establish the reliability of a measurement it is necessary to secure sets of *measured values* taken at different times for the same values of the *instrument readings* of the independent parameters. The *reproducibility* may be evaluated in one of two ways: (*a*) When a statistically significant set of measured values has been taken, the standard deviation will be considered a measure of *reproducibility*. (*b*) When only a small set (two or three) of measurements is available the *reproducibility* will be defined as the maximum difference in the measured values.

Resolution

1 Results communicated to the International Secretariat *must* contain: (*a*) *Experimental values* of the measured parameter expressed in terms of *corrected instrument readings* of the independent parameters; (*b*) estimates of standard deviations s[5] for the above quantities; (*c*) a statement regarding reproducibility and the extent of fluctuations.

2 Results communicated in the form of final papers *must* contain in addition to 1(*a*), 1(*b*), and 1(*c*), also: (*d*) the evaluating equation together with all corrections and (*e*) a statement of the magnitude of

[5] In the simplest case of a normal frequency distribution from a finite number, n, of observations, s^2 may be written $s^2 = \frac{1}{n}\Sigma(x_1 - a)^2$ where $a = \frac{1}{n}\Sigma x_1$.

Table 1 Planned Experimental Work on Properties of Steam

		Range				Dates		
		Pressure		Temperature				
Measurement	Location	Min bars	Max bars	Min C	Max C	Start	Complete	Publish
Pressure volume	Moscow Power Inst.	150	500	370	410	1958	1958	1958
Temperature P-V-T								
	Moscow Power Inst.	200	500	600	650	1958	1958	1958
	Moscow Power Inst.	900	2000	400	1000	1958		
	Moscow Power Inst.		2000+		1000+			
	Univ. of California	100	400–1400	0	750–900	1953	1957	1958
	Canada					1955?		
Critical point	Munich							1959
Enthalpy, H	Imperial College (UK)	30	300	350	750	1955	1959	1959
	Imperial College (UK)	300	1000	350	600	1959	1960	1960
	Imperial College (UK)	5	220	200	600		1939	1958
	S-S Works, W. Ger.	50	550	"Sat"	800	1958	Mid 1960	End 1960
	Moscow Power Inst.	200	400	400	550		1957	1958
	Moscow Power Inst.	300	550	450	600	1958	1960	1960
Joule-Thomson coefficient $\left(\frac{\partial T}{\partial P}\right)_H$	Calif. Inst. Tech.	30	1000	200	800	1956	1959	1959
Isothermal enthalpy-pressure coefficient $\left(\frac{\partial H}{\partial P}\right)_T$	Calif. Inst. Tech.	30	1000	200	800	1958	1960	1960
Specific heat								
Isobaric C_p	Moscow Power Inst.	300	500	280	700		1957	1957
	Moscow Power Inst.							1954
	Moscow Power Inst.	550	700		700		1958	1958
	Moscow Power Inst.		700+	350	450	1957	1959	
	Moscow Power Inst.		2000				1959	
	All-Union Th-Tech. Inst.	20	120	"Sat"	380			1956
	All-Union Th-Tech. Inst.	100	150	375	550			1958
	All-Union Th-Tech. Inst.		200	"Sat"	"Sat"			
	All-Union Th-Tech. Inst.	200+				1958		
	All-Union Th-Tech. Inst.	300	500		700	1958	1959	
	Calif. Inst. Tech.	30	1000	200	800			
Isochoric C_v	Acad. of Sci. USSR	Critical region		Critical region				1957

the *corrections* in relation to the experimental values.

3 When *smoothed values* are included additionally in a communication, the communication *must* include also: (*f*) a statement as to which values are interpolated and which are extrapolated; (*g*) a description of all the details of the smoothing process used; (*h*) a statement about the maximum deviations of *experimental values* from *smoothed values.*

II States for Skeleton Table

In order to accomplish the primary objective of the first meeting of the International Co-ordinating Committee, it was necessary to agree upon the states to be reported in the skeleton tables. Some consideration was given to the use of specific volume and temperature as the independent variables for such a tabulation, but the group, after some deliberation, agreed unanimously that for the present the form of earlier tables should be maintained in which pressure and temperature were the independent variables and volume and enthalpy the dependent variables. As a result of greater interest at higher pressures in general, and the critical regions in particular, the number of values of pressure and temperature to be included was increased somewhat.

III Next Meeting

In order to insure that all interested groups would have an opportunity to prepare skeleton tables, a schedule of dates was arrived at which would permit a year for the submission of experimental data to the Secretariat and a further year for the preparation of skeleton tables by individual delegations in time for a meeting at Munich in the fall of 1960, when the Co-ordinating Committee will convene again for consideration of the tabular information available.

IV Next Plenary Conference

Tentative plans for the sixth International Conference in the spring of 1961 were considered for recommendation to the Secretariat.

On the basis of the foregoing review of the status of research upon the thermodynamic and transport properties of steam, the following trends appear to exist.

Trends

There still is the need for greater emphasis upon thermodynamic consistency of skeleton tables which in themselves do not give a sufficiently detailed description of the thermodynamic properties of water to permit reasonable checks of thermodynamic consistency to be made. If skeleton tables are to be retained in the more distant future, it may be desirable to provide a sufficient number of values of pertinent thermodynamic derivatives at each state recorded to indicate the degree of thermodynamic consistency realized..

With the advent of effective large-scale digital computing equipment, there is a marked resurgence in interest in the application of the so-called "fundamental" equation of state. An empirical expression describing the variation in the Helmholtz free energy as a function of temperature and volume appears a possible special utility since the derivatives of the free energy with respect to commonly employed independent variables will yield directly the values of the thermodynamic properties of engineering interest. Work upon equations of state on steam is now under way in the USSR and the U.S.A. In the United Kingdom methods are being developed for the application of digital computing equipment to the calculation of thermodynamic properties from experimental data without the need for the formulation of equations of state.

The rather unsatisfactory agreement realized among data describing the transport properties of steam leads to concern that a careful review of methods and instruments employed for such measurements should be made in order to be assured that the numerical values reported in fact do represent the particular transport properties quoted. The marked influence of the design of instruments even when used in connection with secondary measurements may be an indication that some data recorded may involve the interaction of other fluxes in such a manner as to adversely influence the primary measurements.

Standing room only at a session of the first international aeronautical congress. Interpreters break the language barrier with simultaneous translations into Spanish, German, French, and English.

Sr. D. Luis de Azcárraga, president, Association of Spanish Aeronautical Engineers, welcomes the Congress from the rostrum at the Instituto Nacional de Previsión, Madrid, Spain

Theodore von Karman, Mem. ASME, honorary president, ICAS, and chairman, AGARD (NATO), delivers the Daniel and Florence Guggenheim Memorial Lecture

Meeting between sessions are *left to right:* Claude Dornier, Dornier-Werke GmbH; Lieutenant General D. Jose Rodriguez y Diaz de Lecea, Minister of Air; Dr. von Karman; and General Nunez, Director General of Industry and Material

First International Aeronautical Congress

Scientists from 27 nations meet in Madrid, September 8–13

Some years ago, Theodore von Karman and the late Daniel Guggenheim were discussing the problems of technical communication among scientists. Dr. von Karman mentioned the desirability of a handbook of aerodynamic theory in order that American scholars might have a starting point for their investigations. He also jokingly noted that this problem is solved much more simply in Europe where young scientists meet in "nice quiet cafés for informal discussions," and that, unfortunately, this situation had no counterpart in the United States. Mr. Guggenheim offered to provide funds for the publication of the book, but said, "I will not go into the cafeteria business—even for science's sake."

The late William F. Durand's "Aerodynamic Theory" was the result of this conversation, but Mr. Guggenheim never went into the cafeteria business. Dr. Durand, world recognized authority on aerodynamics, was 1924–1925 ASME president. (See Mechanical Engineering, October, 1958, pp. 51–52.—Editor.)

Years later another Guggenheim, Harry F., proposed the formation of a world-wide forum for the discussion of common problems in aeronautics and in space technology. He backed up his suggestion with an offer to use the income from the Daniel and Florence Guggenheim Memorial Fund for the Promotion of International Collaboration in the Aeronautical Sciences to provide the necessary financial assistance. Not exactly cafeteria business, but, as a result, for six days, September 8–13, during the first international congress of the International Council of the Aeronautical Sciences (ICAS), a group—600 strong and from 27 countries—met in Madrid, Spain. There they had the opportunity to exchange ideas in the informal manner of the Europeans.

As Dr. von Karman pointed out in a press conference, the congress would have no revolutionary repercussions in aeronautical science throughout the world. It would, however, engender the type of informal personal contact among scientists so vital to the technological breakthrough.

A program of 13 formal technical sessions held at the Instituto Nacional de Previsión and the Palacio de Comunicaciones provided a springboard for the informal discussions—at sidewalk cafés, on strolls through the famous Retiro Park

Gardens, and on treks through the Prado Museum.

Bienvenu

Presiding over the opening of the conference, the Spanish Minister of Air, Lieutenant General Rodriguez y Diaz de Lecea, welcomed the international assemblage of aeronautical scientists. Welcome was extended also by president of the Association of Spanish Aeronautical Engineers, don Luis de Azcárraga, and First Lieutenant Mayor, Sr. Soler. M. Maurice Roy, chairman of the Congress and director general, Office National d'Études et de Recherches Aéronautiques, expressed the gratitude of the Congress for the facilities made available by the Spanish hosts.

Memorial Lectures

Two memorial lectures, the Daniel and Florence Guggenheim Memorial Lecture and the Juan de la Cierva Memorial Lecture, inaugurated the technical portion of the Congress.

Theodore von Karman, Mem. ASME, honorary president of ICAS, and chairman, Advisory Group for Aeronautical Research and Development (AGARD) of NATO, presented the first of these. He traced "Some Significant Developments in Aerodynamics Since 1946," touching upon wing and body theory, piston theory, aerothermochemistry, boundary layer, and turbulent motion. Early in his presentation, he noted that entry into the range of hypersonic speeds introduces certain simplifications. However, these are largely overbalanced by the complications due to high temperatures caused by shock and friction. "The production of heat, an annoyance in flight at moderate Mach numbers, becomes a major problem at hypersonic speeds. Furthermore, and as a new complication, one has to take into account the chemical changes in the medium. . . no longer are we dealing with pure aerodynamics, nor aerothermodynamics; fluid mechanics must now be combined not only with thermodynamics, but also with chemistry." Now more than ever, aeronautical scientists must become "familiar with the methods and results of many sister sciences."

Pedro Blanco Pedraza, aeronautical engineer, Instituto Nacional de Técnica Aeronutica, presented the Juan de la Cierva Memorial Lecture. Sr. Blanco described the contribution of Juan de la Cierva to the development of rotary-wing aircraft. He pointed to the present state of rotary-wing aircraft and to the important part played by Juan de la Cierva in its perfection.

Technical Sessions

In organizing this first international congress of the aeronautical sciences, the committee chose subjects and invited lecturers to meet and discuss problems of mutual interest. Their prime concern was a review of the present status of aeronautical science as it applied to all related spheres. Discussion was limited to atmospheric flight and to nonmilitary aeronautical applications.

At the first of two general sessions, telecommand and telemetering, aerodynamic design for supersonic speeds, and supersonic propulsion by turbojets and ramjets were the subjects considered. Under the topic of hypersonic flow, Newtonian flow theory, dynamics of dissociating gas, and hypervelocity flight investigations were reviewed.

E. R. G. Eckert, Mem. ASME, University of Minnesota, in a session on heat transfer and heat barrier, considered mass-transfer cooling a means to protect high-speed aircraft. During the same session, features of hypersonic heat transfer, heat transfer in flows with separation and by natural convection also at critical state condition, and the adiabatic motion of a gas in a rotating gas were discussed.

Jet engines and noise also generated much interest. Concern was not so much for the jet engines, but for their attending noise and their effects on surrounding structures. Noise is a problem to jet-transport operators because of its direct relationship to the comforts or proficiency, or even the well-being, of the crews and passengers in flight, ground personnel, and the community surrounding the airport. William Littlewood, Mem. ASME, vice-president, American Airlines, in treating the subject, pointed out the relation of noise to the durability and functioning of aircraft structures, and delicate flight equipment. Others speaking on the subject reported on physical and bio-acoustic research in Canada, and the progress in jet-engine noise reduction with the jet silencer.

In the realm of navigation and guidance, C. S. Draper, Fellow ASME, W. Wrigley, and R. B. Woodbury, all of Massachusetts Institute of Technology, outlined the principles of inertial guidance marking their identity with those of celestial body navigation.

N. J. Hoff, Mem. ASME, head, division of aeronautical engineering, Stanford University, reported on the significant new concept of supersonic aircraft designed for a definite finite lifetime. In a session on heat-resistant structures, he reviewed the various causes of the limitations of lifetime.

Other sessions considered boundary-layer control, telemetering, VTOL-STOL, and human engineering.

The technical portion of the Congress was concluded with a second general session which looked ahead to propulsion methods in astronautics, a comparison of various approaches to an electric propulsion system, and the physical basis of magneto-hydrodynamics.

Social Events

On the opening night, members of the Congress attended a reception at the invitation of the Minister of Air. The atmosphere at the air ministry was as far removed from the conference chambers as the Spirit of St. Louis is from Sputnik, yet there could be heard echoes of conservations begun earlier in the day.

At the invitation of the president-mayor of Madrid, the conferees, on another evening, had the opportunity to hear the Madrid Symphony Orchestra present a program of Spanish concert music in the Cecilio Rodriguez Gardens of the Park of Madrid. After the concert—a reception in the exotically landscaped formal gardens.

The final social event of the Congress was the dinner-dance at the Parque Florida. The festivities were concluded by an exhibition of Spanish Folk Dancing presented through the courtesy of the Association of Spanish Aeronautical Engineers.

A New Look in Engineering Education at Pratt Institute

By Warren E. Wilson[1]

The students who enrolled in the School of Engineering at Pratt Institute in Brooklyn this semester saw the "new look" in engineering education. The Report on Evaluation of Engineering Education prepared by a committee of the American Society for Engineering Education during the years 1952–1955, served as a guide for the development of Pratt's new look.

The report is summarized as follows: "Engineering Education must contribute to the development of men who can face new and difficult engineering situations with imagination and competence. Meeting such situations invariably in-

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volves both professional and social responsibilities. The Committee considers that scientifically oriented engineering curriculums are essential to achieve these ends."

With the background of the Evaluation Report, the knowledge that it had made an impact on engineering education, and supported by the knowledge obtained from the ASME questionnaire,[2] the writer came to the conclusion that the time was ripe for a significant effort to establish a quite different approach to engineering education on a small campus where the philosophy might penetrate equally all departments of the engineering school. The engineering science curriculum at Penn State, Purdue, and Michigan had been established and Case Institute was organizing its curriculum in this field when the writer became Dean of Engineering at Pratt Institute. The trustees of this Institute endorsed the concept of a new approach in engineering education and authorized a quite free hand to develop what they hope will be a very strong school in the field of science and engineering education. Several objectives were established, as follows:

1 All curriculums will have a definite scientific orientation.

2 Two years and possibly three years will be common.

3 A Department of Engineering Science will be established.

4 A student body capable of assimilating the material in the new curriculums will be developed.

During the past two years significant steps have been taken to attain the stated objectives. The first and perhaps the most important was taken when the faculty endorsed a common two-year program for all curriculums. The first two years are identical for all curriculums with the exception of two courses in the sophomore year which are different for Chemical Engineering only, and there is a possibility that this deviation will ultimately be eliminated. The common two years provide a solid core of studies in mathematics through differential equations, two years of physics, a year of chemistry, four courses in Engineering Science, and four courses in the Humanities. The third year is presently under consideration and it is expected that it will contain a common core of mathematics and engineering science for all curriculums. A Humanities program extending through the four years is being designed by a committee, and will include an average of one course per semester. The subject matter will be well integrated and present to the student a logical sequence of courses rather than a group of unassociated electives. Out of this program have evolved curriculums in chemical engineering, electrical engineering, engineering science, industrial engineering, and mechanical engineering, all with a definite scientific orientation and common core of basic material strongly recommended by the Evaluation Committee as necessary in future curriculums.

A department of Engineering Science has been established, and it offers a curriculum leading to the degree at the undergraduate level in that field. This curriculum has no specialization in any of the traditional areas, but includes, in the senior year, engineering analysis and design of a broad and general nature. Initially it was planned to offer this curriculum only to the students who entered in September, 1957, and later. However, the freshman class that entered in September, 1956, learned of this curriculum and fifteen members of the class petitioned to be permitted to pursue this course of study beginning in their sophomore year. Since these were some of the very best students in the class, permission was granted, and in September, 1957, they entered the curriculum as sophomores. By dint of great perseverance and hard work on the part of the staff of the department of Engineering Science, these students have made up the deficiencies of their freshman year and completed their sophomore year in the new curriculum. The enthusiastic reception accorded this new course of study by the students was most gratifying.

When undertaking this educational program it was realized that a student body of exceptional quality would be needed, consequently entrance requirements have been upgraded, and a much more selective process used in determining what students should be admitted. The entering class in September, 1957, numbered approximately 175 and these were selected from a total group of applicants numbering approximately 1700. A class of about the same size will be admitted next September from a group of applicants slightly larger in number than last year. Quite obviously it is very necessary to build a strong staff to carry out a program of this type and every effort is being made to attain this objective. During the two-year period and including the new staff engaged for next fall, 20 new faculty members will have been added, 70 per cent with doctor's degrees.

To those who are familiar with the history of Pratt Institute as a Technical Institute offering first a two-year program for technicians and later a three-year program of similar nature, the plans for a highly scientifically oriented school of engineering may well be a significant and newsworthy item. For those associated with the effort, there is a challenge that promises a most exciting opportunity to pioneer in an area of greatest importance for the future of our country.

[2] Published in MECHANICAL ENGINEERING, March and April, 1955.

Program for International Conference on Scientific Information

THE program for the International Conference on Scientific Information, which is scheduled to be held in Washington, D. C., at the Mayflower Hotel, Nov. 16–21, 1958, is in its final stages of development. On the evening of November 16, the conference will be officially opened by an address by Sir Lindor Brown, secretary for Biological Sciences, the Royal Society. On the evening of November 19, there will be a banquet at which Detlev W. Bronk, president, National Academy of Sciences, will speak.

A total of 75 papers prepared by 98 authors and coauthors has been accepted and printed for distribution in advance of the conference to all participants (authors and members of discussion panels) and registered observers. These papers will serve as a basis for panel discussions, arranged according to the seven areas of the program agenda and chaired by the following persons:

Area 1. Requirements of scientists for scientific literature and reference services: knowledge now available and methods of ascertaining their requirements. (Panel leader: Philip Morse, department of physics, Massachusetts Institute of Technology.)

Area 2. The function and effectiveness of abstracting and indexing services for storage and retrieval of scientific information. (Panel leader: Elmer Hutchisson, American Institute of Physics.)

Area 3. Effectiveness of scientific monographs, compendia, and specialized information centers in meeting the needs of scientists: present trends and new and proposed techniques and types of services. (Panel leader: Alexander King, European Productivity Agency.)

Area 4. Organization of information for storage and search: comparative characteristics of existing systems. (Panel leader: Eric de Grolier, Centre Français d'Echanges et de Documentation Techniques.)

Area 5. Organization of knowledge for storage and retrospective search: intellectual problems and equipment consideration in the design of new systems. (Panel leader: Gilbert W. King, IBM Research Center.)

Area 6. Organization of knowledge for storage and retrospective search: possibility for a general theory of storage and search. (Panel leader: John W. Tukey, department of mathematics, Princeton University.)

Area 7. Responsibilities of governmental bodies, professional societies, universities, and research and industrial organizations to provide improved information services and to promote research in documentation. (Panel leader: Verner Clapp, Council on Library Resources.)

Also in attendance will be approximately 500 observers from some 20 foreign countries who already have registered to attend as observers.

In addition to the program discussion sessions, several excursions are planned to such installations as the National Bureau of Standards, the Library of Congress, and other agencies engaged in activities relevant to the conference program.

The conference will close with a reception for participants at the National Academy of Sciences on Friday evening.

ICA Revises Method of Selecting Architectural and Engineering Services

The International Co-operation Administration (ICA) has recently revised its previous method of selecting firms for professional architectural and engineering services. After Aug. 1, 1958, this procedure was put in effect:

The Office of Industrial Resources (S/IND), which is under the Office of the Deputy Director for Technical Services (DD/S), will, after giving consideration to all firms listed in its Uniterm Index, select not less than three firms which are judged to be best qualified for the project under consideration and will list these firms in order of preference. Following are the principal factors which will be considered in making the selection:

(*a*) Reputation and standing of the firm and its principal members in performance of the contemplated work.

(*b*) Specialized experience in the field of activity for which the services are required.

(*c*) Past record in performing work for ICA, for other Government agencies and private industry, including performance from the standpoint of costs, quality of work, and ability to meet schedules.

(*d*) The volume of work of the firm with ICA in previous years and the extent to which the firm is currently engaged in other work.

(*e*) Ability to assign an adequate number of qualified key personnel from the firm's own organization, including a competent supervising representative having considerable experience in responsible positions on similar work.

(*f*) The portions of the work the firm is able to perform with its own forces when required.

(*g*) Ability of the firm to furnish or to obtain required materials and equipment.

(*h*) Financial resources.

(*i*) Familiarity with the locality in which the project is located.

S/IND will submit the list of firms in order of preference to a selection panel composed of the following: Director, Office of Contract Relations (S/CO), Chairman; Director, Office of Industrial Resources; and Deputy Regional Director for geographic area concerned.

This panel will consider the recommendations and information submitted by S/IND and will establish a firm list of companies in order of agreed preference. Unanimous decisions of the panel will be final. In case of disagreement, the matter will be forwarded to the Deputy Director for Technical Services who will make the final decision.

S/CO will negotiate with the first firm on the list received from the panel to obtain a mutually satisfactory contract. At this time, the firm will make known its estimate of cost for performing the services and the fee. If agreement is not reached, negotiations will be terminated and the firm so notified. Negotiations will then be initiated with the next firm on the list and so on until an agreement is reached.

All firms desiring to perform services for the International Co-operation Administration should take immediate steps to file their qualifications with the Office of Industrial Resources if they have not already done so. Those firms which have previously filed with ICA should up-date information previously submitted to the extent that it is obsolete or incomplete. Information filed should cover the factors listed above on which firms will be selected.

1959 Heat Transfer and Fluid Mechanics Institute Papers Invited

The 1959 Heat Transfer and Fluid Mechanics Institute will be held at the University of California, Los Angeles, June 11–13, 1959. Original contributions are invited dealing with any fundamental aspect of heat transfer and fluid mechanics. Emphasis is given to topics covering more than one special field of engineering science. For the 1959 Institute it is planned to stress particularly those problems in heat transfer and fluid mechanics which require consideration of thermal phenomena, chemical reactions, electromagnetic fields, thermal radiations, and low pressures.

Titles and abstracts of proposed papers should be submitted by Nov. 1, 1958; final papers by Feb. 15, 1959. Preliminary plans for the program of the Institute are made on a basis of abstracts; acceptance is based on the review of final papers. Final selection of papers will be completed by March 15; program of the Institute will be issued in May. All papers will be preprinted in full and copies mailed out to preregistered participants three weeks before the meeting.

The main virtue of the Institute is in providing an opportunity for authoritative discussion of fundamental ideas at an early stage of their development. Consequently, the preprints are made available for discussion only and not as contributions in their final form to permanent literature. For this purpose, the authors may feel free to submit their papers subsequently to any journal or transactions of their own choice for publication.

General Chairman: E. L. Knuth, Department of Engineering, University of California, Los Angeles. *Committee Chairmen*: Papers—A. Magner, Marquardt Aircraft Company, Van Nuys, Calif., and E. Meyer, Rocketdyne, Canoga Park, Calif. Program—D. Masson, The RAND Corp., Santa Monica, Calif. *Arrangements*—J. C. Dillon, Department of Engineering, University of California, Los Angeles, Calif.

The papers presented at the 1958 Heat Transfer and Fluid Mechanics have been published and may be purchased from Stanford University Press, Stanford, Calif., at $7.50 a copy.

First Symposium on Naval Structural Mechanics Held at Stanford University

APPROXIMATELY 400 scientific and engineering representatives of industry, universities, and government assembled at Stanford University, Stanford, Calif., August 11–14, to hear selected leaders in structural mechanics research present timely reviews of various basic aspects of this field of interest to the Navy. All appeared to feel that their attendance there was professionally fruitful. The meeting was sponsored jointly by the Office of Naval Research Mechanics Branch and Stanford University, under the co-chairmanship of Prof. N. J. Hoff, Mem. ASME, head, Division of Aeronautical Engineering, and Prof. J. N. Goodier, Mem. ASME, head, Division of Engineering Mechanics. It was unclassified and open to the public.

Intended as a critical review of the state of knowledge, the topics covered and the speakers during the four days of sessions were: Linear Elasticity, by E. Sternberg; Elastic Shells, by E. Reissner; Shell Instability, by E. E. Sechler and Y. C. Fung; Nonlinear Elasticity, by R. S. Rivlin; Vibration and Waves in Elastic Bars and Plates, by R. D. Mindlin; Experimental Wave Propagation, by H. Kolsky; Dynamic Interaction Between Structure and Fluid, by H. H. Bleich; Aerohydroelasticity, by A. H. Flax; Structure-Borne Noise, by M. C. Junger; Thermoelasticity and Thermoplasticity, by B. A. Boley; Plasticity, by D. C. Drucker; Viscoelasticity, by E. H. Lee; Photoelasticity and Photoplasticity, by M. Hetényi; Instrumentation (Mechanical Problems), by I. Vigness; New Materials, by J. J. Harwood, N. E. Promisel, and J. Maltz; Fracture Mechanics, by G. R. Irwin; and Computer Applications, by H. Greenberg.

Following the stimulating opening of the symposium by Rear Admiral Rawson Bennett, Chief of Naval Research, and by J. E. Wallace Sterling and Frederick E. Terman, President and Provost, respectively, of Stanford University, was a particularly well-received presentation from the Navy's viewpoint. Entitled "Problems Related to the Design of Structures for Ships of the U. S. Navy," and presented by Captain J. A. Brown, USN, of the Bureau of Ships, it afforded the scientific community assembled a comprehensive and challenging account of the Navy's current problems in that area.

An interesting aspect of the symposium was a visit, organized together with the Navy's Bureau of Ordnance, to Lockheed Aircraft's Missile Systems Division at Sunnyvale, where the chief item of interest was the facility, and the movies of its operation, for testing the underwater launching trajectory and exit of scale models of the Navy's promising Polaris missile.

Social flavor was provided by a well-attended banquet at Ricky's, Palo Alto, which featured an interesting address on "Whistling Smoke Rings," by Dr. T. C. Poulter of Stanford Research Institute, and brief talks on the place of ONR in Defense Research, and plans for future symposiums in this series, by Dr. F. J. Weyl, new Research Director of that Office, and Phillip Eisenberg, Head of its Mechanics Branch, respectively. It was indicated that each of the future symposiums in this series would cover only current research results in one or two specific areas of the structural mechanics field.

No time or place has yet been considered for the next meeting. Dr. W. Ramberg, chairman of the ASME Applied Mechanics Division, represented the Society at this banquet and cordially extended its best wishes for the success of Symposium Series. He was joined in this felicitation by Prof. M. Hetényi representing the Society for Experimental Stress Analysis.

Arrangements are being made for publication of the Proceedings of this Symposium within eight months. Inquiries in this regard should be addressed to either of the meeting co-chairmen, Prof. N. J. Hoff and Prof. J. N. Goodier, or Mechanics Branch, Office of Naval Research.

Second Symposium on Naval Hydrodynamics Draws Large Audience to Washington

THE Second Symposium on Naval Hydrodynamics was held in Washington, D. C., from August 25 to 29, 1958, under the auspices of the Office of Naval Research and the National Academy of Sciences-National Research Council. Directed at a discussion of recent research progress in two areas of current Naval importance, namely aerodynamic and hydrodynamic noise, and supercavitating and ventilating flows, the meeting attracted the participation of some 370 representatives from all branches of the armed services, the maritime, aircraft, hydraulic machinery, atomic energy, and missile industries. Thirty of the attendees, including seven of the speakers, represented research efforts in these areas in Canada, the United Kingdom, the Netherlands, France, and Germany.

The first two days of the Symposium, which was under the general chairmanship of Phillip Eisenberg, Head of ONR's Mechanics Branch, were devoted to the noise phase, and the following papers were presented: Theory and Experiment in Aerodynamic Noise Research, by A. Powell of UCLA; A Theory of Turbulence Dynamics, by R. H. Kraichnan of NYU; A Survey of Pertinent Research at The Max-Planck Institut für Strömungsforschung, Göttingen, by E. A. Müller of that Institute; Aspects of Aerodynamic Noise, by E. Mollø-Christensen and H. W. Liepmann of CIT; Sound Generation by Surface Roughness in a Turbulent Boundary Layer, by E. J. Skudrzyk and G. Haddle of ORL, Pennsylvania State University; The Fluctuating Surface Pressures Created by Turbulent Boundary Layers on Hypersonic Vehicles, by E. E. Callaghan of NACA; Excitation of Acoustic Resonators by Flow, by U. Ingard of M.I.T.; Sound Radiation Into a Closed Space From Boundary Layer Turbulence, by I. Dyer of Bolt, Beranek, and Newman; Recent Experiments on Ultrasonic Cavitation at Göttingen, by E. Meyer, of the III Physikalisches Institut there; Cavitation Noise, by H. M. Fitzpatrick of DTMB; and Pressure Waves From Collapsing Cavities, by T. Brooke Benjamin of The University of Cambridge.

The presentation and discussion of supercavitating and ventilated flow papers occupied the last two days of the symposium. By title and author, there were: New Developments in the Theory of Supercavitating Flows, by M. P. Tulin, presently of ONR's London Branch Office; Jets, Wakes, and Cavities, by G. Birkhoff of Harvard University; Cavity Flow of Viscous Liquids in Narrow Spaces, by G. I. Taylor and P. G. Saffman of the University of Cambridge; Linearized Theory of Supercavitating Hydrofoils With Finite Cavity in Steady and Unsteady Flow, by R. Timman of The Technische Hogeschool, Delft; Unsteady Supercavitating Flows, by T. Y. Wu of CIT; The Influence of Aspect Ratio and Depth of Submersion on Supercavitating Hydrofoils Operating at Zero Cavitation Number, by V. E. Johnson,

Jr., NACA; Wall Effects in Cavity Flows, by H. Cohen and R. C. Di Prima of RPI; Some Aerodynamic Cavity Flows in Flight Propulsion Systems, by W. G. Cornell of the General Electric Company; The Mechanics of Ventilation Inception, by K. L. Wadlin of the NACA; Ventilation of Bodies Piercing a Free Surface, by J. M. Wetzel of the University of Minnesota; Air Entrainment Behind Artificially Inflated Cavities, by I. J. Campbell and D. V. Hilborne of the Admiralty Research Laboratory, Teddington; On Supercavitating Propellers, by H. Lerbs, Director, Hamburgische Schiffbau Versuchsanstalt; The Design and Estimated Performance of a Series of Supercavitating Propellers, by A. J. Tachmindji and W. B. Morgan of the USN DTMB; and an Experimental Study of Cavitating Inducer Pumps, by A. J. Acosta of CIT.

Wednesday, the midday of the symposium, was devoted to conducted tours of the David Taylor Model Basin and the Naval Research Laboratory, where many of the attendees received, through well-executed briefings and demonstrations, a first-hand glimpse of the Navy's pertinent research facilities and programs in these and allied areas of Naval interest.

All appeared to enjoy the symposium thoroughly, and enthusiastically expressed their satisfaction with its themes and accomplishments. Present plans are for the Proceedings to be published within eight months by the Government Printing Office. Inquiries in this regard should be addressed to the Superintendent of Documents of that Office, Washington 25, D. C., or to Head, Mechanics Branch, Office of Naval Research.

The recent Navy Press Release on advances in supercavitating flows, described as the most significant hydrodynamic accomplishment in 30 years, was made in connection with this symposium.

PEOPLE

Honors and Awards. Jerome C. Hunsaker, Hon. Mem. ASME, emeritus professor, Massachusetts Institute of Technology, was presented the Navy Distinguished Public Service Award by the Honorable G. Norton, Assistant Secretary of the Navy for Air. This award, the highest conferred on civilians by the Department of the Navy, recognizes Dr. Hunsaker's singularly outstanding contributions in the fields of scientific research and development. His penetrating insight into technical and organizational problems has proved invaluable to the Navy.

William Littlewood, Mem. ASME, vice-president for equipment research, American Airlines, has been named the 1958 recipient of the Daniel Guggenheim Medal. He was cited for "leadership and continuous personal participation over a quarter of a century in developing the equipment and operating techniques of air transport."

Mervin J. Kelly, president, Bell Laboratories, has been named to receive the 1959 John Fritz Medal for his achievements in electronics, leadership of great industrial research, and the national defense through science and technology. The award is administered by ASCE, AIME, ASME, and AIEE.

Linton E. Grinter, Mem. ASME, dean of the graduate school and director, University of Florida, received the Lamme Medal for distinguished service in engineering education.

Richard Redwood Deupree, chairman of the board, The Procter & Gamble Company, Cincinnati, Ohio, has been chosen to receive the 1958 Henry Laurence Gantt Gold Medal. The award is presented annually by AMA and ASME for "distinguished achievement in industrial management as a service to the community."

General E. W. Rawlings, Commander, Air Materiel Command, presents the Exceptional Civilian Service Award to Frederick E. Moskovics. The award, the highest honor granted to employees by the Air Force, was presented to Mr. Moskovics for his work as special consultant on B-52 and J-57 programs.

Leo B. Moore, associate professor of industrial management, Massachusetts Institute of Technology, and Roger E. Gay, director of cataloging, standardization, and inspection, Department of Defense, received this year's awards for outstanding service in standardization, presented jointly by the Standards Engineers Society and the American Society for Testing Materials. Mr. Moore was recipient of the SES-ASTM 1958 award for outstanding contributions to the literature of standards, and Mr. Gay, industrial executive, for outstanding service in the interest of standardization.

Stephen P. Timoshenko, Hon. Mem. ASME, professor emeritus, Stanford University, Palo Alto, Calif., who played a vital part in the development of engineering mechanics in this country, has received an Elliott Cresson Medal from The Franklin Institute.

Arthur H. Morey, Fellow ASME, Erie, Pa., manager, railroad locomotive advance engineering unit, General Electric Company, who began his career as a railroad fireman, will receive the George R. Henderson Medal from The Franklin Institute for his work in connection with the development of the gas turbine-electric locomotive.

James Bailey, Mem. ASME, consulting engineer, Plax Corporation, Hartford, Conn., received an Edward Longstreth medal from The Franklin Institute for his development of the plastic bottle.

Peter T. Bizon, a senior at the University of Pittsburgh, has been awarded the Sylvia W. Farny Scholarship sponsored by the Woman's Auxiliary to The American Society of Mechanical Engineers.

Mr. Bizon is in the department of mechanical engineering, headed by Professor N. Lewis Buck, Mem. ASME.

Established in 1952 in honor of the late Sylvia W. Farny, a past national president and an honorary member of the Woman's Auxiliary to the ASME, the fund awards at least one $500 scholarship to an undergraduate in mechanical engineering for use in his or her final year of study.

Selection is based on character, scholastic achievement, and financial need.

Heinz Nordhoff, director general of the Volkswagenwerk; the late Ferdinand Porsche, designer of the Volkswagen and their co-workers were named recipients of the 1958 Elmer A. Sperry Award. This is the first time that the Sperry Award has been given to a foreign engineer or engineering team. Although no date has been established for formal presentation of the Sperry medal, it is expected that Dr. Nordhoff and Ferry Porsche, son of the designer, will come to the United States later this year to receive the award in person.

Hugh L. Dryden, Fellow ASME, newly appointed deputy director, National Aeronautics Space Administration, received the John H. Rice Gold Medal. The medal was presented by the American Ordnance Association at a meeting in San Francisco, Calif.

New Officers. Vice-Admiral George F. Hussey, Jr., USN (Ret), Mem. ASME, managing director of the American Standards Association, was elected vice-president of the International Organization for Standardization at the 1958 triennial meeting of the international standards body in Harrogate, England. Edward Wegelius, president, Finnish Standards Association, was elected president of the International Organization for Standardization.

John H. King, president, Archer-Daniels-Midland Company (Canada) Ltd., Toronto, has been chosen to serve as a national director of Foundrymen's Society.

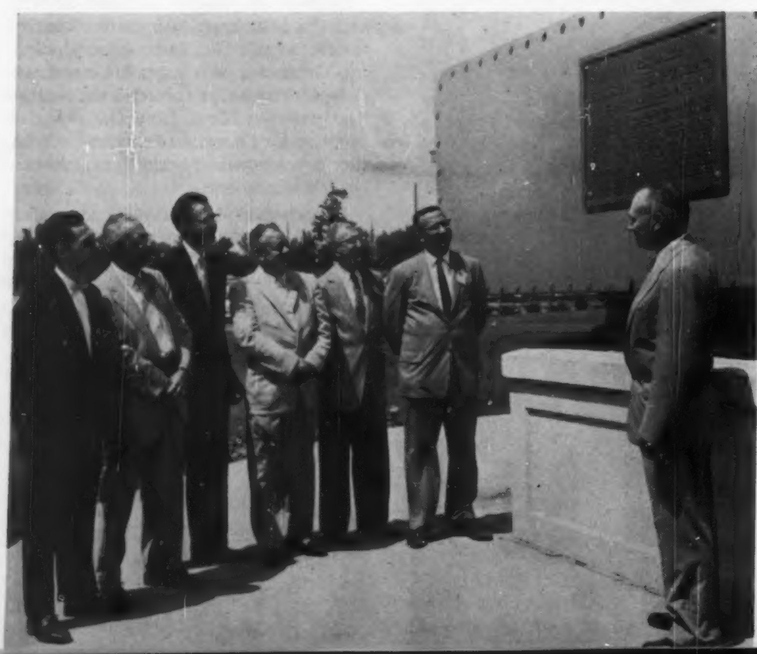
Henry C. Frost, assistant chief engineer, Corn Products Refining Company, Chicago, Ill., was elected president of the Instrument Society of America at the society's annual instrument-automation conference and exhibit in Philadelphia, Pa.

Robert H. Swoyer, Sr., Mem. ASME, mechanical engineering department, Pennsylvania Power and Light Company, Allentown, Pa., has been elected chairman of sectional committee Z74 of the American Standards Association. The committee is concerned with fundamentals of performance of effluent air and gas cleaning equipment.

Campus Data. Richard Gilman Folsom, Fellow ASME, was formally installed as president of Rensselaer Polytechnic Institute in inaugural ceremonies on Saturday, October 4.

Stothe P. Kezios, Mem. ASME, has been advanced to the rank of full professor at the Illinois Institute of Technology. Professor Kezios is in the department of mechanical engineering, and is a specialist in heat transfer, thermodynamics, and fluid flow.

Begin at Beginning. **ASME Power Test Code Subcommittee meeting in Schenectady N. Y., during their study to revise the Power Test Code, inspected dedication plaque on the first large Curtiss steam turbine-generator, forerunner of today's modern powermakers. Monument is located in front of General Electric's steam turbine-generator development laboratory. A. I. Dahl, *right*, of General Electric's Engineering Physics and Analysis Laboratory, was host to other committee members who are, *left to right*, C. A. Macaluso, Worthington Corporation, Harrison, N. J.; C. A. Vogelsang, Minneapolis-Honeywell Corporation, Philadelphia, Pa.; R. D. Thompson, Taylor Instrument Companies, Rochester, N. Y.; J. W. Murdock, U. S. Naval Boiler & Turbine Laboratory, Philadelphia, Pa.; R. C. Stroud, Leeds & Northrup Company, Philadelphia, Pa.; and G. A. Black, Westinghouse Electric Corporation, Idaho Falls, Idaho.**



MEETINGS OF OTHER SOCIETIES

Nov. 12–14

Society for Experimental Stress Analysis, annual meeting, Hotel Sheraton-Ten Eyck, Albany, N. Y.

Nov. 17–21

The Society of the Plastics Industry, Inc., annual conference and exposition, International Amphitheatre, Chicago, Ill.

Nov. 17–21

American Rocket Society, annual meeting, Statler-Hilton Hotel, New York, N. Y.

Nov. 18–20

American Standards Association, ninth national conference, Hotel Roosevelt, New York, N. Y.

Nov. 24–26

American Physical Society, annual meeting of division of fluid dynamics, Hotel San Diego, San Diego, Calif.

Nov. 28–Dec. 4

Radio Communication and Electronic Engineering Association and the Office Appliance and Business Equipment Trades Association, electronic computer and business symposium, London, England.

Dec. 1–3

The American Society of Refrigerating Engineers, semi-annual meeting, Roosevelt Hotel, New Orleans, La.

Dec. 2–4

Electronic Industries Association, conference on reliable electrical connections, Statler-Hilton Hotel, Dallas, Texas.

Dec. 3–5

American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Association for Computing Machinery, eastern joint computer conference, Bellevue-Stratford Hotel, Philadelphia, Pa.

Dec. 7–10

American Institute of Chemical Engineers, annual meeting, Netherlands-Hilton Hotel, Cincinnati, Ohio.

Dec. 8–10

American Nuclear Society, annual meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

(*ASME Coming Events, see page 160*)

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

1958 ASME Annual Meeting Promises Diverse Week of Engineering Events Program

Statler-Hilton and Sheraton-McAlpin Hotels, New York City, November 30 to December 5

"New Frontiers in Engineering—Key to Mankind's Progress" will be the theme of the 1958 Annual Meeting of The American Society of Mechanical Engineers to be held in New York, N. Y., November 30 to December 5. Peacetime applications of nuclear fission and fusion, design of jet transport planes including the latest Russian aircraft, and new developments in control of the automatic factory will be among the topics discussed at more than 140 technical sessions scheduled.

In addition, there will be reports by more than 400 authors on recent engineering advances in power plant design, machine design, metals engineering, rubber and plastics, applied mechanics, and a dozen other fields. A complete program of the 1958 Annual Meeting appeared in Mechanical Engineering, October, 1958, pp. 115–124.

The meeting, expected to attract several thousand engineers from all parts of the world, will be quartered at the Hotels Statler-Hilton and Sheraton-McAlpin.

Concurrent with the meeting will be the National Exposition of Power and Mechanical Engineering at the New York Coliseum. The show, held every two years, is under the auspices of ASME.

Nuclear engineering sessions at the Annual Meeting will include some 15 papers dealing with using the power of the atom for the benefit of mankind. In addition to new developments in design of "conventional" nuclear generating plants (those powered by the fissioning of uranium), speakers from laboratories and industrial concerns across the nation will discuss techniques for deriving power from radioisotopes, nonmilitary use of thermonuclear explosions, and conversion of plasma energy into electrical energy.

At other sessions, speakers will discuss methods of storing solar energy by electrical or chemical means.

Papers sponsored by the Society's Aviation Division will deal with engineering aspects of the new American jet passenger transports, and of experimental VTOL (vertical-take-off-landing) aircraft. A paper on the Russian jet transport, the TU-104, is scheduled for presentation either by Prof. A. N. Tupelov, its designer, or by his representative. British engineers will describe engineering aspects of the Vickers Vanguard and operating experience on the Rolls-Royce Turbo Prop. There will also be a paper on the French-built Caravelle transport.

A special summary of progress in the field of gas turbines will be presented, including sections on their use in aircraft, rockets and missiles, ships, railroads, and automobiles and industrial, stationary, and nuclear power.

Other sessions will deal with professional problems faced by engineers such as administration and human factors.

High lights of the meeting, in addition to technical sessions will include trips to industrial installations in the New York area.

Luncheon and dinner speakers during the week include ASME President J. N. Landis; Philip Sporn, Hon. Mem. ASME, president of American Gas and Electric Service Corporation; Walter E. Boveri, Brown Boveri Company of Switzerland; Joseph W. Barker, past-president of ASME and president and chairman of the board of the Research Corporation, New York; and E. V. Murphree, president of the Esso Research and Engineering Company.

R. A. Beyer, professor of mechanical engineering, Technical University, Munich, Germany; H. A. Johnson, Mem. ASME, University of California; Robert A. Riester, Mem. ASME, Carrier Corporation; J. H. Furbay, World Wide Educational Program, TWA, Inc.; and E. C. Warrick, Rockwell Manufacturing Company, will also be among the speakers.

The traditional Sunday Evening discussion will be held at the Hotel Statler-Hilton on November 30, and will precede the week's technical sessions.

Streamlined Banquet

With the co-operation of Council and the Board on Honors, the Meetings Committee has arranged to limit honors presentation during the annual banquet to the ASME Medal and certificates of Honorary Membership. Seating this year will be limited to the capacity of the Grand Ballroom in the Statler-Hilton.

With a considerably shorter banquet program, members will find it satisfying to spend more time socially with the honored guests and at the dancing party that will follow in the Georgian Room.

National Power Conference . . .

. . . looks at the station of the future, nuclear plants, steam-generator design trends, and high-voltage d-c transmission

A LOOK at the power station of the future, a survey of design trends and current practice, nuclear reports on an improved gas-cooled concept and the progress of commercial plants, and a consideration of high-voltage d-c transmission, were included in the model program of the National Power Conference, Boston, Mass., Sept. 29–Oct. 1, 1958. The conference was sponsored jointly by The American Society of Mechanical Engineers and the American Institute of Electrical Engineers Power Divisions in co-operation with the Boston Sections of both societies.

The more than 900 who attended also had an opportunity to observe the reporter system of paper presentation in operation at several of the sessions. Reporters in four of the sessions not only condensed as many as four papers in the time usually required for one, but in several cases added greatly to the value of the papers by interjecting their own comments, asking authors for additional information, summarizing from several related papers, or pointing up the significance of particular developments. Reaction to the method was varied and the system depends heavily on the background and manner of presentation of the reporter. The method has previously demonstrated its value in some sessions of the ASME Annual Meeting for representing papers that have been given at another conference.

Luncheons and Banquet

ASME President James N. Landis, who was scheduled to speak at the opening luncheon, relinquished his time and introduced Harvey E. Bumgardner, Mem. ASME, and assistant to the president of the Detroit Edison Company. Mr. Bumgardner summarized the visit of a group of top-level utility and manufacturing executives to power installations in the USSR. The visit was arranged by the U. S. Department of State and the Ministry of Power Stations in the Soviet Union. W. E. Hopkins, Mem. ASME, and chairman of the Executive Committee of the ASME Power Division, was the toastmaster.

Captain J. S. Dunsford, USN, delivered the banquet address, and W. M. Rohsenow, Mem. ASME, and professor of mechanical engineering at M.I.T., was the toastmaster. Thomas Astley Fearnside, chief mechanical engineer, Stone & Webster Engineering Corporation, received a certificate of his election to the grade of Fellow.

Captain Dunsford described the U. S. Navy's nuclear program, commenting on the rapidity with which it developed. Less than four years after the *Nautilus* trial, 33 nuclear submarines and three nuclear surface vessels are authorized. These vessels have set new records and demonstrated the possibilities of nuclear propulsion. The *Nautilus* surfaced only once in a 5000-mile trip—to go through the Panama Canal. The *Sargo* was to be commissioned September 30, the day after Capt. Dunsford's address. Six more vessels have been authorized of the "teardrop design" utilized in the *Skipjack*, recently launched at Groton, Conn. The *Triton*, largest of the submarines built, is in the same class as the largest destroyers. It has two reactors, developed in prototype at General Electric's West Milton, N. Y., plant. Other specialized submarines are being developed.

Captain Dunsford stated that, as the program has developed, some generalizations have become possible concerning nuclear propulsion: (*a*) The inhibiting effect on the commanding officer of the cost of operating at high speed with conventional fuels is removed; (*b*) the addition of extra systems for safety and reliability has taken away much of the initial simplicity of the nuclear concept; (*c*) high-temperature sodium plants are heavier and more difficult to maintain; (*d*) there are no shortcuts to lighter and more economical plants, and each new plant is a compromise between maximum engineering development and the need to build a fighting ship on schedule.

At the concluding luncheon, T. M. Linville, Mem. ASME, and manager of research operations, Research Laboratory, General Electric Company, reviewed the steps leading to the current member-giving campaign for the United

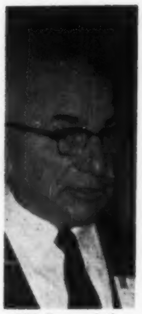
Captain J. S. Dunsford, USN, delivers banquet address. ASME Past-president W. F. Ryan is at *left,* toastmaster W. M. Rohsenow at *right*

Authors, *left to right,* Argersinger, Wilson, Hawley, Powell, and Stewart, whose papers on Steam Generator Design Trends were reported by A. Kirkpatrick, *at right*

Sessions were well attended with a total attendance of over 900

Kramer

Skrotzki



Kirkpatrick

Bumgardner

Breuer

Landis

Krieg

National Power Conference figures: Reporters Andrew Kramer, Mem. ASME, B. G. A. Skrotzki, Mem. ASME, and A. Kirkpatrick; luncheon speaker Harvey E. Bumgardner, Mem. ASME; G. D. Breuer who presented a paper on d-c transmission; ASME President James N. Landis; author E. H. Krieg, Fellow ASME

Engineering Center. His talk was given in the absence, due to illness, of Walter J. Barrett, AIEE past-president. J. C. Hitt, chairman of the AIEE Boston Section, was toastmaster.

In stating the need for a new building, Mr. Linville pointed out that 30 years ago the auditorium in the present building was considered pretty plush and something of which to be proud. The first five floors were devoted then to meeting rooms, and much of the space has since been adapted to offices. The building long since has been inadequate to quarter a reasonable share of the profession, and a survey has indicated that the present building could not be suitably reconstructed.

Mr. Linville reviewed the specific steps that led to the decision to remain in midtown New York.

As an aid to those planning member-giving campaigns in their sections, Mr. Linville spoke of the experience in the AIEE Schenectady Section which has raised 140 per cent of the $27-per-member quota. The average of $53 from those who contributed works out to $40 per member when all members are considered. The 42 members in the Adirondack subsection—all of whom were personally contacted in a period of two weeks—contributed $1826. Schenectady treated everyone alike, with a personal contact and a suggestion of annual contributions for each of three years equal to their dues, but also based requests on ability. The largest single contribution was $1500.

Mr. Linville concluded by stating that, in the site opposite the United Nations, the new facilities will be on a better basis than the engineering profession has ever known.

Inspection Trips

Inspection trips were taken to the General Electric Company's Lynn, Mass., plant; to the Salem Harbor plant of the New England Electric System; and to the Mystic Station of the Boston Edison Company.

Technical Sessions

The technical sessions opened with "A Look at the Future in Power-Station Design," by E. H. Krieg, Fellow ASME (see pp. 66–70). In commenting on the paper, W. F. Ryan, ASME past-president, pointed out that the predicted 16-million-kw plant would probably use methods unknown today. While extrapolating present trends was somewhat like calculating the amount of horses and hay needed to carry two million commuters to New York before rapid transit had developed, it was the only way of obtaining some idea of what future requirements would be. He also added humorously that from present appearances 16 million kw would not be enough to supply the auxiliary power required for a thermonuclear fusion plant.

Three ASME papers on boiler-feed-pump drive applications were combined in a reporter-type presentation by B. G. A. Skrotzki, Mem. ASME, associate editor of *Power*. One of the principal developments outlined was the utilization of turbine drive to reduce auxiliary-power requirements and the inefficiency of converting mechanical power to electrical and back to mechanical. While such application appears to be recent, a 1931 Pacific Gas and Electric design was noted. Still in use, it called for a variable-speed noncondensing turbine-driven feed pump.

A concurrent session dealt with career possibilities for young engineers in the power field. Frederick A. Kramer of Public Service Electric and Gas Company of New Jersey pointed out that the abundant energy of hydrogen-fusion generation will become available within the lifetime of today's young engineer and that it will produce dramatic changes in everyday life and in the utility industry. Engineers will have new roles and responsibilities. At present, system expansion and the development of nuclear reactors challenge the engineer's ingenuity and technical ability. Some of these opportunities were described in detail by V. F. Estcourt, Fellow ASME (see pp. 89–93). The educational requirements for a career in power production were outlined by J. H. Keenan, Fellow ASME; J. A. Fay, Mem. ASME; and G. N. Hatsopoulos of the Department of Mechanical Engineering at M.I.T., and by Gordon S. Brown, head of the M.I.T. Department of Electrical Engineering.

Andrew Kramer, Mem. ASME, editor of *Atomics*, was reporter for a group of AIEE papers describing progress on the Yankee, Dresden, and Enrico Fermi nuclear power stations as well as a conceptual paper on a 125-electrical-mw pebble-bed reactor plant. The reactor would utilize small spheres ($^3/_4$-in-diam in the blanket and $1^1/_2$-in-diam in the core) of graphite containing UO_2 plus ThO_2, in the core, and ThO_2 in the blanket. Gas cooling is used and if perfected the system will represent a sophistication of the Calder Hall type of gas-cooled graphite-moderated nuclear reactor. Two other nuclear papers, presented by the authors, completed the session. The first was on performance tests of a new vertical steam generator for land or

marine applications, and the other was a feasibility study on the application of the boiling-water reactor to merchant-ship propulsion.

An exploratory look at d-c transmission has indicated that its use in America is probably remote since it appears to be economical only for distances over 500 miles, for undersea transmission, or in cases where large supplies of untransportable cheap fuel are remote from the power requirements. Discussion revealed that although d-c transmission will probably not be utilized for at least 10 years, research is needed now. Philadelphia Electric already has a laboratory model of a d-c transmission system and is undertaking further studies.

A paper solicited with State Department approval was presented for the author, which described work done in the Soviet Union on high-voltage long-distance d-c power transmission. The paper by A. M. Nekrasov of the technical department, Ministry of Power Stations, and A. V. Posse, chief engineer of the Scientific Research Institute of Direct Current, described experience on the 112-km underground-cable d-c Kashira-Moscow transmission line, the projected 500-km Stalingrad-Donbas line, and developmental work on d-c transmission.

A consideration of the economics of industrial power and trends in power-plant design for modern paper mills completed the session.

At the concluding session, A. Kirkpatrick of Chas. T. Main, Inc., was reporter for a group of four ASME papers on steam-generator design trends (see pp. 71–83), and an AIEE paper was presented which dealt with five years of experience on the Consolidated Edison System with protection of turbine generators and boilers by automatic tripping.

Availability List: ASME Power Conference

The papers in this list are available in separate copy form until July 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers.

58—PWR-1 Performance Tests of a Vertical Steam Generator for Nuclear Power Plants, by R. L. Coit and C. C. Peake

58—PWR-2 Pumping Power in the Feedwater Cycle, by S. M. Arnow and J. L. Allen

58—PWR-3 Trends in Power-Plant Design for Modern Paper Mills, by T. J. Judge

58—PWR-4 A Look at the Future in Power-Station Design, by E. H. Kribo

58—PWR-5 Industrial Power is Different, by R. K. Patterson

58—PWR-6 An Engineering Career in the Power Field, by V. F. Estcourt

58—PWR-7 Power and Growth. . . .The Challenge and the Promise, by F. A. Kramer

58—PWR-8 Five Years of Experience on the Consolidated Edison System With Protection of Turbine Generators and Boilers by Automatic Tripping, by W. C. Beattie, H. A. Bauman, J. M. Driscoll, P. T. Onderdonk, and R. L. Webb

58—PWR-9 Application of Boiling-Water Reactor for Merchant Ship Propulsion, by R. L. Schmidt

58—PWR-10 Education in Mechanical Engineering for Power Production, by J. H. Keenan, J. A. Fay, and G. N. Hatsopoulos

58—PWR-11 The Integration of Single Turbine-Driven Feed Pumps in Large Generating Units, by J. A. Tillinghast and J. E. Dolan

58—PWR-12 Education for Expanding Horizons in Electric Power, by G. S. Brown

58—PWR-13 The Yankee Atomic Electric Plant, by W. E. Shoupp, R. J. Coe, and W. C. Woodman

58—PWR-14 A Preview of Tomorrow's Boilers, by E. M. Powell and J. I. Argersinger

58—PWR-15 Design Requirements for Steam Generation With High-Cost Fuels, by C. F. Hawley

58—PWR-16 Modern Steam-Generator Designs, by D. R. Wilson

58—PWR-17 Trends in Present-Day Boiler Design, by D. B. Stewart

58—PWR-18 Evolution of the Boiler Feed-Pump Drive, by R. A. Baker

ASME COMING EVENTS

November 30–December 5

ASME Annual Meeting, Statler-Hilton and Sheraton-McAlpin Hotels, New York, N. Y.

March 8–12, 1959

ASME Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati, Ohio

March 8–12, 1959

ASME Aviation Conference, Statler-Hilton Hotel, Los Angeles, Calif.

March 29–April 1, 1959

ASME Instruments and Regulators Conference, Case Institute of Technology, Cleveland, Ohio

April 5–10, 1959

Nuclear Congress, Cleveland Auditorium, Cleveland, Ohio

April 13–15, 1959

ASME Hydraulics Conference, University of Michigan, Ann Arbor, Mich.

April 19–23, 1959

ASME Oil and Gas Power Conference, Shamrock-Hilton Hotel, Houston, Texas

April 23–24, 1959

ASME Management-SAM Conference, Statler-Hilton Hotel, New York, N. Y.

April 29–May 3, 1959

ASME Metals Engineering Conference, Sheraton-Ten Eyck Hotel, Albany, N. Y.

May 4–5, 1959

ASME Maintenance and Plant Engineering Conference, Edgewater Beach Hotel, Chicago, Ill.

May 12–14, 1959

ASME Production Engineering Conference, Statler-Hilton Hotel, Detroit, Mich.

May 25–28, 1959

ASME Design Engineering Conference, Convention Hall, Philadelphia, Pa.

June 14–18, 1959

ASME Semi-Annual Meeting, Chase-Park Plaza Hotel, St. Louis, Mo.

June 18–20, 1959

ASME Applied Mechanics Conference, Virginia Polytechnic Institute, Blacksburg, Va.

August 9–12, 1959

ASME-AIChE Heat-Transfer Conference, University of Connecticut, Storrs, Conn.

September 17–18, 1959

ASME-AIEE Engineering Management Conference, Statler-Hilton Hotel, Los Angeles, Calif.

September 20–23, 1959

ASME Petroleum Mechanical Engineering Conference, Rice Hotel, Houston, Texas

November 29–December 4, 1959

ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

(*For Meetings of Other Societies, see page 156*)

Note: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

Nominations Open for 1960 ASME Officers

Section Advisers to Regional Nominating Committee Member Provide Channel for Suggestions Requested From Each Member

At the first meeting of the 1959 National Nominating Committee in Detroit last June, much emphasis was laid on the democratic process by which officers of the ASME are chosen. The Committee is thoroughly imbued with the essential principle that must govern all their deliberations—the office must seek the man, and not the inverse.

The Nominating Committee therefore cannot discharge its duties properly without your help—yes, you, the ordinary member from Walla Walla, Waco, Wichita, Waycross, or Waterbury. It is you in each of the 87 sections of our great Society who know the men in your section—your friends—who have been "carrying the ball" for ASME. These are the men who should be the future Regional and National officers of our Society. The National Nominating Committee may never know of these dedicated workers unless you act in their behalf—certainly they will not actively seek office themselves.

A direct line of communication has been established for your use. Each section has been asked to appoint an adviser on nominations. Your duly elected regional member, who together with the seven other regions' representatives (and the three selected by committee conference) make up the National Nominating Committee, will serve as the chairman of this group of advisers in your region. If you know men in your section who have the acknowledged qualities of outstanding ability and leadership in their profession, please suggest them to your section adviser on nominations, or better yet, act as sponsor for such men. Your nomination sponsorship must be on a form which you can secure from headquarters in New York or from your regional nominating committee member. The names and addresses of all the nominating committee members and their alternates were published in the August, 1958, issue of Mechanical Engineering, pp. 135 and 136.

Those of you who are active in the Professional Divisions as well as those in section activities should be particularly able to give sound recommendations to your section adviser on nominations. While the Boards, Committees, and Professional Divisions make recommendations through nominating conferences provided for in the Constitution and By-Laws of the Society, your suggestions to them can also be invaluable. Accordingly, you may make your nomination through your group's representative or directly to William G. McLean, Secretary, 1959 Nominating Committee ASME, Department of Mechanics, Lafayette College, Easton, Pa.

Offices to Be Filled for 1960

President	To serve 1 Year
Vice-President, Region I	To serve 2 Years
Vice-President, Region III	To serve 2 Years
Vice-President, Region V	To serve 2 Years
Vice-President, Region VII	To serve 2 Years
Three Directors (at large)	Each to serve 4 Years

It is your obligation, privilege, and responsibility as well as that of every other member of the Society to assist the National Nominating Committee in obtaining the best men available for officers of The American Society of Mechanical Engineers.

Oil and Gas Engine Power Costs Report Issued by ASME

The "1956 Report on Oil and Gas Engine Power Costs" contains operating cost data from 95 plants. The report, submitted by the Subcommittee on Oil and Gas Engine Power Cost, Oil and Gas Power Division, The American Society of Mechanical Engineers, presents data for 1955 and previous years.

Information on performance and production cost of oil and gas-engine power plants is presented. Included in the report are data from 95 oil and gas-engine generating plants containing 404 engines, totaling 518,640 rated bhp. The total net output from these plants amounted to 871,932,831 kwhr.

Copies cost $3 (20 per cent discount to ASME Members), and may be obtained by writing to: ASME Order Department, 29 W. 39th Street, New York 18, N. Y.

ASME Publications Available on Microcards

The Microcard Foundation recently announced the availability of four publications of The American Society of Mechanical Engineers; a fifth is in preparation. They are: "60-Year Index" (1880–1939), $3; "10-Year Index" (1940–1949), $2; *ASME Transactions*, vols. 55–78 (1933–1956), $200; *Journal of Applied Mechanics*, vols. 1–23 (1933–1956), $60; and currently in preparation is Mechanical Engineering, vols. 78–79 (1956–1957).

The Microcard edition of these publications appears approximately one year after the original. In the case of Mechanical Engineering, the volumes prior to volume 78 will be published if there is enough demand. Microcarding, a method of publication rather than copying process, does not realize a savings unless at least 15 copies of an item are made. *Applied Mechanics Reviews* is being considered for publication.

Microcard editions of journals are of value in that they completely eliminate binding costs and reduce storage costs by 95 per cent. A Microcard holds 40 to 80 pages, and 85 cards can be filed in an inch of drawer space.

Other advantages of Microcards are as follows:

1 They come with author and title headings as well as with Library of Congress card numbers. This simplifies cataloging and classification, and insures that each card is easily identifiable.

2 Microcards are 3 × 5 in. and can, therefore, be stored in standard file drawers.

3 Microcards do not require heat and moisture controls for preservation.

4 Microcards are made on permanent paper stock and will remain clearly legible indefinitely.

5 Microcards are produced photographically and will not rub off or smudge.

6 Microcards generally provide savings in original purchase price especially in regard to out-of-print works.

The Microcard Foundation, an affiliate of the University of Wisconsin Press, Madison, Wis., is a publisher of original and reprint works on Microcards and is instrumental in promoting the use and development of micro-opaque methods of publication. "Microcard" is a trademark registered in the U. S. Patent Office.

Left to right:
J. S. Rearick, Mem. ASME; O. L. Lewis, Mem. ASME; and L. W. Ledgerwood, Jr., Assoc. Mem. ASME, at Denver Conference

E. B. Wilcox, banquet speaker, discusses Communism and Middle East oil

H. H. Meredith, Jr., chairman, ASME Petroleum Division

General view during a session at Petroleum Mechanical Engineering Conference, Sept. 22–24

R. C. Hadley, Mem. ASME, chairman, Conference Arrangements Committee

Petroleum Men Explore Avenues Leading to Economic and Industrial

For three days engineers from all over the country, Canada, and Venezuela delved a mile deep into the mechanical-engineering problems of the petroleum industry in the mile-high city of Denver, Colo.

At the Cosmopolitan Hotel from September 22 through 24, more than 600 members and guests of The American Society of Mechanical Engineers attended 24 technical sessions of the Petroleum Mechanical Engineering Conference. They heard more than 50 papers dealing with refining, production, transportation, and manufacture; attended five panel discussions which were devoted to compressors, strain-gage applications, standardization, and automatic custody transfer; and two symposiums—one on plastic piping and the other on uses of digital computers as used by gas and liquid pipeline companies.

A session when petroleum engineers did some soul searching—making engineers more effective—brought to light some interesting discussion.

Digests of ASME numbered papers appear in this and in subsequent issues of Mechanical Engineering.

Social activities rounded out a carefully designed and comprehensive program. Those who arrived early, on Sunday, were guests of the Denver Section at a "Get Acquainted" reception. On Monday there was a welcoming luncheon; and on Tuesday five Industry Luncheons made it possible for those in attendance to lunch with others in their field of interest and to meet the working committees in their branch of the industry. The traditional Social Hour and Banquet capped the social events of the conference.

Technical Sessions

Transportation led the parade of topics which sparked the technical sessions. Of primary concern in this category was pipeline design. In the past decade the pipeline industry has grown rapidly, specifications and codes for pipelines have been greatly improved. Steelmaking practices have improved, and special line pipe steels have been investigated and are available with greater toughness. Improvements in the submerged-arc method of welding are providing uniform automatic welds both on the inside and outside of the pipe. Methods of testing—the ring test, burst tests, and certain nondestructive tests, and radiographic examination—all are contributing to greater efficiency and economy in the pipeline industry.

Definite interest was shown in automatic measurement procedures involved in the custody measurements of receipts into a pipeline gathering system. Lease Automatic Custody Transfer (LACT) measurement is favored by pipeline operators for the following reasons: Reduction in pipeline gathering costs; improved measurement accuracy; and possible improved efficiency.

Because of the strong economic incentive it offers, LACT equipment is coming into wide use. Work is still needed to facilitate the division of costs and responsibilities between producing and pipeline companies, to reduce the expense of obtaining regulatory body approvals in some areas, and to simplify and reduce the first cost of the installations. For good long-term performance, designs must provide for reliability and ease of trouble shooting, and competent maintenance service must be made available.

Electronic computers are rapidly gaining acceptance in all phases of industry. The petroleum industry too is employing computers in many areas. Computers are finding applications in compressor station analysis, in evaluation of a natural-gas gathering system design, in analysis of pipeline investment. Digital computers, also, find uses for technical calculations in the oil and gas industry and in the solution of petroleum and refinery engineering problems.

Codes and standards received considerable attention. The ASME Unfired Pressure Vessel Code, Section VIII, came up for discussion at a panel. Another panel considered the new ASA B31.3 Piping Code—Section for Petroleum Refineries.

Low-cost field compressor installations received consideration. The development of relatively lightweight compact integral compressors is making "packaged compressor plants" possible. These compressor plants are complete operating units incorporating all necessary equipment, piping, and accessories required for satisfactory operation. Flexibility, portability, short field-construction time, and high salvageability have reduced

E. W. Jacobson, Director ASME

M. L. Rizzone, Mem. ASME

ASME Petroleum Division Executive Committee members, *left to right:* A. F. Rhodes, J. P. Mooney, and T. L. White

J. S. Rearick, chairman, ASME Petroleum Division Advisory Committee

G. W. Lunsford, chairman, Membership Committee, ASME Petroleum Division

Improvement During ASME Denver Conference

They sought methods of improvement in areas of materials, applications, and engineers themselves

costs considerably in the industry.

Sessions dealing with drilling equipment covered the "V" 1500 slush pump, fluid knock in oil-field mud pumps due to separation, and how to get the most mud power at the bottom of the drill string.

Aluminum oxide ceramics in the petroleum industry and epoxy resin coatings received attention at materials sessions, as did chemical and physical properties of line pipe and weld repairs.

Manufacturers concerned themselves with test stands for turbodrills, testing methods for rubber sealing materials, and a new microscopic caliper.

A session of general interest to all engineers, since its concern was the more efficient employment of engineers, brought out a number of thoughts on the subject. Recruiting the engineer, evaluation and development of technical personnel, and the mechanism of brainstorming were discussed.

Availability List: ASME Petroleum Conference

The papers in this list are available in separate copy form until July 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers.

58—PET-1 Company-Wide Standardization. . . .An Engineering Viewpoint, by J. Zaba and H. Schaefer

58—PET-2 New Fracturing Header and Discharge System, by C. A. Pitts

58—PET-3 Torispherical Shells—A Caution to Designers, by G. D. Galletly

58—PET-4 Aerodynamic Vibration of Tall Cylindrical Columns, by R. G. Baird

58—PET-5 Fluid Knock in Oil-Field Mud Pumps Due to Separation, by S. L. Collier

58—PET-6 How to Get the Most Hydraulic Power at the Bottom of the Drill String in Rotary Drilling, by R. W. Colebrook

58—PET-7 Creativity and Brainstorming, by A. B. Wintringham

58—PET-8 Evaluation and Development of Technical Personnel, by W. E. Alexander

58—PET-9 An Electromechanical Caliper for the Classification of Oil-Field Tubing, by W. G. Boyle and W. M. Kelly

58—PET-10 Experience With PD Meters and Fixed-Volume Tank-Measurement Procedures in LACT, by L. S. Wrightsman

58—PET-11 Recruiting the Engineer, by R. G. Alleman

58—PET-12 A New Analytical Approach to Drill-Pipe Breakage, by J. L. Bogdanoff and J. E. Goldberg

58—PET-13 Vibration of Vertical Pressure Vessels, by C. E. Freese

58—PET-14 Steady-State Creep Analysis of the Weight Loadings of Furnace Tubes on Multiple Supports, by J. L. Jacobowitz and C. K. Mader

58—PET-15 Approach, Parameters, and Interpretation of the V-1500 Slush Pump, by W. R. Barry

58—PET-16 Mass-Flow Metering, by L. L. Laurence and H. E. Trekell

58—PET-17 Pipe Stress in Offshore Pipeline Construction, by Noah Roads

58—PET-18 Experience and Evaluation of Deep Groundbeds, by R. L. Bullock

58—PET-19 Epoxy Resin Coatings—Factors Affecting Their Selection and Performance, by C. M. Jekot and A. J. DaValle

58—PET-20 The Strength of Thick-Walled Cylinders, by B. Crossland, S. M. Jorgensen, and J. A. Bones

58—PET-21 Drilling by Vibration, by R. Simon

58—PET-22 Improved Characteristics of a Crank-Balanced Pumping Unit, by J. P. Byrd

58—PET-23 A Program for Inspection and Maintenance of Fired Heaters in Gasoline Plants, by Peter von Wiesenthal

58—PET-24 The Use of Digital Computers for Petroleum and Refinery Engineering Problems, by R. J. Baxter

58—PET-25 The Packometer. . .An Electrical Approach to Paperwork Simplification, by H. A. Larberg

58—PET-26 Computational Analysis of Pipeline Investment, by T. R. Young

58—PET-27 Use of Digital Computers for Technical Calculations in the Oil and Gas Industry, by W. S. Pickrell

58—PET-28 Evaluation of Natural Gas-Gathering System Design With an Electronic Computer, by L. R. Henry and R. B. Peritz

58—PET-29 The Electronic Computer and Compressor Station Analysis, J. Manry, III

58—PET-30 Aluminum-Oxide Ceramics in the Petroleum Industry, by D. E. Howes

58—PET-31 Testing Methods for Rubber Sealing Materials, by A. F. Rhodes

58—PET-32 Thermal Analysis and Design of Intermediate Heads in Pressure Vessels, by J. T. McKeon and G. P. Eschenbrenner

58—PET-33 Minimum Practical Housing of Low-Cost Compressor Stations, by B. J. Thompson

58—PET-34 Strength of Welded Joints in Low-Alloy Steels at Elevated Temperatures, by W. B. Hoyt

58—PET-35 Packaged Compressor Plants Earn Their Popularity, by R. W. Evans

58—PET-36 Survey of Operating and Maintenance Expenses for Small Skid-Mounted Compressor Units, by P. B. Edmondson and Harry Evans

Conducted for the National Junior Committee

N. J. VIEHMANN[1]

JUNIOR FORUM

The Engineer and His God By F. Everett Reed[2]

WHAT is an engineer's God? Is he like everyone else's God? This is an engineering publication; why is the Junior Forum concerned with this question? This belongs in another field that has no connection with our job.

All these questions immediately come to us when we face a title like this. I will try to explain in engineers' terms why an engineer should be concerned about his God and why his God is different from other people's God.

What do we mean by God? This is a terrible question to ask a mechanical engineer who is concerned with things we can see and feel. But surely we deal with things that also are abstract. By our experience with these abstract things we begin to feel that we know them. I, for example, have been studying ships and methods of loading them which involve millions of dollars, but it is unusual for me actually to handle a hundred dollars at one time. The million-dollar figure is a huge extrapolation which I will never see but can picture and work with. Another abstract thing that we deal with is the Btu. We can define it and work with it and, using it, build marvelous pieces of equipment. However, we will never see it or feel it. As for entropy, I am not sure we will even understand it, but we can use it.

In many ways our God is like this. Being engineers we would like to define and to measure Him but He is too abstract for this. We do better to think of God in terms of limits. For many of us, He represents the ultimate of the noble things we can conceive. Are we thinking of wisdom? God, we say, knows everything. Are we thinking of unselfishness? God gives all He has. Are we thinking of power? God is all-powerful. Are we concerned with gentleness? God, with all His power and the manifestations we see of it, is also the ultimate in gentleness. Beauty? God, we say, presents to our eyes the beauties of color and form that are so wonderful that we are emotionally led to worship the God represented by them.

There are, however, other attributes which ascribe to God. There are times when a man is given capabilities that are far beyond his normal abilities. Great music, great pictures, even great engineering accomplishments can only be explained in terms of some force that permeates us and makes us greater than we might otherwise be. We ascribe this to the same limitless concept that we call God. On a personal basis there are times when there wells up within everyone some subconscious comparison of how he would deal with a disturbing problem as compared with the way an "ideal" person would do this. We attribute this internal counseling, called by the Society of Friends the "Inner Light," to God speaking to us. The ability to understand and to respond to the guidance of this subconscious idealization is developed by experience, but all of us at some time or other feel a personal guidance that we cannot understand.

Through past ages men have been awe-struck by great things that they could not comprehend. They have collected their experiences and inspirations and handed them down as part of the world's religious concepts. This heritage helps each of us in the development of our own concepts and beliefs.

With this inadequate expression of what God, in part, represents, it is clear that everyone's picture of God will be colored by his experience and background. An engineer's God is probably rather systematic. He is not likely to violate Newton's Laws of Motion. He

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[1] Product Planning Engineer, Western Electric Company, North Andover, Mass. Assoc. Mem. ASME.

[2] Senior Mechanical Engineer, Technical Operations Inc., Burlington, Mass. Mem. ASME.

Chairman's Corner

SEVEN of the 17 ASME Honors are restricted to the young members of the Society. These honors for distinguished service and contributions to engineering literature are:

1 *Pi Tau Sigma Gold Medal Award*—(Gold Medal and a monetary supplement to cover expenses to an ASME meeting.) This award is given annually to a young mechanical engineer for achievement in mechanical engineering within ten years after graduation.

2 *Junior Award*—(Engrossed certificate and $50.) This award is given annually for original technical papers, presented and submitted for publication by an Associate Member not more than 30 years of age.

3 *Spirit of St. Louis Junior Award*—(Engrossed certificate and $50.) This award is given every third year for a paper presented on an aeronautical-engineering subject by an Associate Member not more than 30 years of age.

4 *Arthur L. Williston Medal Award* (Engrossed certificate, bronze medal, and an honorarium.) This award is given annually for the best brief or thesis by an undergraduate student or a junior engineer (within two years of baccalaureate degree) setting forth ideas "fostering a spirit of civic Service."

5 *Charles T. Main Award*—(Engrossed certificate and $150.) This award is given annually for the original work and paper on an announced topic by a Student Member.

6 *Student Awards*—(Engrossed certificate and $25.) This award is given annually for the best original paper by a Student Member in each classification.

7 *Old Guard Prize*—(Engrossed certificate and $150.) This prize is given annually for the best presentation from 12 Regional Student Conferences by a Student Member.

Are you helping yourself and your Society by active participation?

W. V. Chambers, Chairman, NJC; General Electric Company, Evendale, Ohio

F. Everett Reed

is vast enough to encompass the dimensions and energy of the universe. As a personal God, He probably guides an engineer much less dramatically than a person of different temperament. Maybe we will even question the existence of a God because we cannot touch or see Him, but everyone will have the moments of inspiration, of new courage, and of inner guidance that some ascribe to God.

Next, why are engineers concerned about God? Because the concept that everyone sets as his ultimate good or his ultimate greatness establishes the basis on which he works. Unless we as engineers can set standards that are high, we can never live up to the full potential which we possess. Unless we make the effort to cultivate within us the spirit that appreciates beauty, that shows concern for fellow men, that provides the "Inner Light," that gives us a greater goal for our endeavors than our own comfort or power. . . . . we fail to really live.

ASME Elects New Officers by Letter Ballot

As reported by the tellers of election, 1959 officers, R. W. Cockrell, E. P. Lange, and John de S. Coutinho, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 23, 1958. The total number of ballots cast was 12,513, of these 69 were thrown out as defective.

	Votes for	*Votes against*
For President		
Glenn B. Warren......	12,403	41
For Regional Vice-President—serve one year		
Charles H. Coogan, Jr.	12,394	50
For Regional Vice-Presidents—serve two years		
Gordon R. Hahn......	12,392	52
John W. Little........	12,370	74
Thomas J. Dolan......	12,384	60
Harold Grasse........	12,380	64
For Directors—serve four years		
Arthur M. Perrin......	12,392	52
Richard G. Folsom....	12,386	58

The new officers will be introduced and installed in office during the 1958 Annual meeting of the Society to be held at the Statler-Hilton Hotel, New York, N. Y., November 30 through December 5.

Biographical sketches of the newly elected officers were published in the August, 1958, issue of Mechanical Engineering, pp. 126–130. ASME Annual, AC-10, published early each year, contains complete lists of officers and personnel composing the Council, Boards, and Committees of the Society.

ASME CODES AND STANDARDS WORKSHOP

Interpretations of 1955 Code for Pressure Piping

From time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinions of the Committee.

Pending revision of the Code for Pressure Piping, ASA B31.1-1955, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Cases No. 33 and 34 are published herewith as interim actions of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

Annulment of Cases

The following cases are annulled:

Case No.	Reason for Annulment
17	Material not included in Table 1 will now be handled by each Code Section individually.
28	This material has been included in the latest edition of B16.5.

Case No. 33
(Case for API 5LX Pipe)

Inquiry: May pipe conforming to API Specification 5LX be used under the rules of Section 3 of ASA B31?

Reply: It is the opinion of the Committee that pipe meeting Grades X42 and X52 of Specification API 5LX is permitted for use at a metal temperature not to exceed 300 F in refineries under Division A piping with the limitation that this pipe is not to be used in hydrocarbon service within process unit limits.

The allowable stress values for the pipe shall be as shown in the accompanying table.

STRESS VALUES FOR CASE NO. 33

Grade	*S Psi, for Metal Temperatures in Deg F Not to Exceed* 100	200	300
5LX42	20,000	19,000	18,200
5LX52	22,000	21,000	20,000

STRESS VALUES FOR

Material	ASTM Spec	Grade	Tensile Strength, Min	Values of S Psi for Temperatures in Deg F											
				—20 to 100	200	300	400	500	600	650	700	750	800	850	900
Stainless Steel	A376	TP304	75000	18750	16650	15000	13650	12500	11600	11200	10800	10400	10000	9700	9400
		TP316	75000	18750	18750	17900	17500	17200	17100	17050	17000	16900	16750	16500	16000
		TP348	75000	18750	18750	17000	15800	15200	14900	14850	14800	14700	14550	14300	14100
	A358*	TP304	75000	17800	15800	14250	12950	11900	11000	10650	10250	9900	9500	9200	8950
		TP316	75000	17800	17800	17000	16600	16350	16250	16200	16150	16050	15900	15700	15200
		TP321, TP347, TP348	75000	17800	17800	16150	15000	14450	14450	14100	14050	13950	13800	13600	13400

* These stress values include a joint factor of 0.95 and apply to pipe in which the longitudinal weld is radiographed.

The accompanying joint factors are to be appropriately applied to the stresses given.

WELD JOINT FACTORS FOR CASE NO. 33

Weld Joint Factor E

Type of Joint	Basic E Factor
1. Arc or Gas Weld	
a. Double Welded Butt, as Welded	0.85
b. Double Welded Butt, with Full Weld Penetration and Joints Prepared as Specified in Par. UW-51(b) of Sec. VIII of the ASME Boiler & Pressure Vessel Code	0.90*
2. Electric Resistance Weld & Electric Flash Weld	0.85

* *E* Factor = 1.00 if this type joint is 100 per cent radiographed.

Case No. 34

Inquiry: May austenitic steel pipe conforming to ASTM Specification A376, types 304, 316 and 347, and to ASTM Specification A358, types 304, 316, 321, 347 and 348, be used under Section 1 of the Code for Pressure Piping?

Reply: It is the opinion of the Committee that austenitic steel pipe conforming to ASTM Specification A376, types 304, 316 and 348, and to ASTM Specification A358, types 304, 316, 321, 347 and 348, may be used under Section 1 of the Code for Pressure Piping with the accompanying allowable stress values.

Standard Sizes of Shipping Containers

Herbert H. Hall, Mem. ASME, was named chairman of Sectional Committee MH5, Standard Sizes of Shipping Containers, at the organizational meeting of the committee in the Engineers' Club, New York City, July 30, 1958. Fred Muller, Jr., was named secretary.

Eighty representatives of organizations concerned attended the meeting. The project was requested under ASA Procedure by the Society, which is administrative sponsor. The American Materials Handling Society is co-sponsor. The scope, as approved at the meeting, is: "Standardization of sizes of pallet containers, cargo containers, and van containers for integrated transportation with optimum carrier interchange."

Five subcommittees were authorized: (1) Pallet Containers, T. J. White, chairman; (2) Van Containers, John J. Clutz and John Gilbreth, co-chairmen; (3) International Co-ordination, John R. Immer, chairman; (4) Cargo Containers, C. J. Heinrich, chairman; and (5) Executive Committee, H. H. Hall, chairman.

New Standards Approved

The following new standards have been approved as American Standard and are available from the ASME Order Department, 29 West 39th St., New York 18, N. Y.

Steel Butt-Welding Fittings, B16.9-1958

Butt-Welding Ends, B16.25-1958

Drafting Practice: Gears, Splines, and Serrations, Y14.7-1958

Test Code for Speed-Governing Systems for Steam-Turbine-Generator Units

By C. L. Avery, Chairman of PTC Committee No. 20

The Test Code for Speed-Governing Systems for Steam-Turbine-Generator Units (PTC 20.1-58) will be published in November, 1958. This Code is the first part of the work assigned to Power Test Codes Committee No. 20 on Speed, Temperature, and Pressure Responsive Governors. Other Codes contemplated by the Committee are: (*a*) Emergency Governors for Steam-Turbine-Generator Units and (*b*) Pressure Regulating Systems for Steam-Turbine-Generator Units.

The previous Test Code for Speed Responsive Governors issued in 1927 is obsolete and obviously out of date. It emphasized certain test procedures which were primarily checks on design characteristics. This category of testing has been omitted from the new code which covers field testing methods to determine all significant operating characteristics such as are specified as necessary for satisfactory speed governing. These characteristics are given in the AIEE-ASME Recommended Specifications for Speed Governing of Steam Turbines Intended to Drive Electric Generators Rated 500 Kw and Up (AIEE Publication No. 600—May, 1949).

The new Test Code provides standard procedures for routine, commercial, and acceptance tests of steam-turbine-generator unit speed-governing systems. It will implement the AIEE-ASME recommended specifications and prove of value to engineers who are active in the field of power generation.

The purpose of this code is to establish rules and procedures for the conduct of tests to determine the following characteristics of steam-turbine-generator unit speed-governing systems: (*a*) steady-state speed regulation, (*b*) steady-state incremental speed regulation, (*c*) dead band of the speed-governing system, (*d*) stability indexes, (*e*) speed-changer governing range, (*f*) speed-changer synchronizing range, (*g*) speed-changer load-reducing time, and (*h*) overspeed.

The Code is applicable to the testing of speed-governing systems for steam-turbine-generator units rated 500 kw and up, and with the steam turbines classified as follows:

(*a*) Straight condensing, straight noncondensing, and nonautomatic-extraction turbines without initial and/or exhaust steam-pressure control

(*b*) Straight condensing, straight noncondensing, and nonautomatic-extraction turbines with initial and/or exhaust steam-pressure control, and

(*c*) Automatic-extraction and mixed-pressure turbines.

The members of PTC Committee No. 20 are: C. L. Avery, *Chairman*, Woodward Governor Company; W. C. Astley, *Vice-Chairman*, Philadelphia Electric Company; W. L. H. Doyle (retired), Caterpillar Tractor Company; W. B. Hess, Safe Harbor Water Power Corpora-

CASE NO. 34

Not to Exceed

950	1000	1050	1100	1150	1200
9100	8800	8500	7500	5750	4500
15100	14000	12200	10400	8500	6800
13850	13500	13100	10300	7600	5000
8650	8350	8100	7100	5450	4300
14350	13300	11600	9900	8100	6450
13150	12800	12450	9800	7200	4750

tion; P. G. Ipsen, General Electric Company; C. E. Kenney, Allis-Chalmers Manufacturing Company; S. Logan Kerr, consulting engineer; J. B. Prather, Gibbs & Hill, Inc.; Raymond Sheppard, General Electric Company; J. C. Spahr, Westinghouse Electric Corporation; H. Steen-Johnsen, Elliott Company; M. J. Steinberg, Consolidated Edison Co. of New York, Inc.; and H. E. Stickle, Boston Edison Company. Until his death A. F. Schwendner of Westinghouse Electric Corporation was also a member of the Committee.

Pamphlet copies of the Code may be ordered from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. The price is $3 a copy.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of The American Society of Mechanical Engineers was held in the rooms of the Society on Sept. 5, 1958. There were present: J. N. Landis, chairman, who presided; E. W. Allardt, W. H. Byrne, L. N. Rowley, and G. B. Warren, of the Committee; E. G. Bailey, past-president; A. W. Weber, vice-president; V. Weaver Smith and Joseph Pope, directors; E. J. Kates, treasurer; H. J. Bauer, assistant treasurer; W. F. Thompson, ASME representative on UET; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; D. C. A. Bosworth and W. E. Reaser, assistant secretaries; and Ernest Hartford, consultant. The following actions are of general interest:

Dues of Members in Foreign Countries. The President appointed a committee consisting of V. W. Smith, chairman, J. B. Barker, R. B. Lea, and L. N. Rowley to study ASME Policy on dues of members in foreign countries.

Co-ordinating Committee on Critical Tables. Formation was authorized of a Co-ordinating Committee on Critical Tables under the jurisdiction of the Research Executive Committee, with representation from the Research Executive Committee, the Metals Engineering Handbook Board, appropriate activities under the Board on Codes and Standards and such other Society activities as may be appropriate to co-ordinate the Society interest in the Office of Critical Tables and to advise the Society representative on the Advisory Board on Critical Tables, National Academy of Sciences-National Research Council.

Meetings and Conferences. The following schedule of meetings and conferences was noted: 1959 Semi-Annual Meeting, June 14–18, 1959, Chase-Park Plaza Hotel, St. Louis, Mo.; Gas Turbine Power Conference, March 8–11, 1959, Cincinnati, Ohio; 1959 Maintenance and Plant Engineering Conference, May 4–5, 1959, Edgewater Beach Hotel, Chicago, Ill.; and 1963 Annual Meeting, Nov. 17–22, 1963, Hotels Bellevue-Stratford, John Bartrum, and Sylvania, Philadelphia, Pa.

Custodian Funds. Approval was voted of the establishment of custodian funds for the ASME Maintenance and Plant Engineering and the Materials Handling Divisions.

Sections. Approval was voted of the formation of the Paducah Group of the Louisville Section with headquarters at Paducah.

ECPD. The formal report of ASME representatives on Engineers' Council for Professional Development was approved.

U. S. National Committee on Theoretical and Applied Mechanics. A revision of the charter of the U. S. National Committee on Theoretical and Applied Mechanics, on which ASME is represented, was approved. The revision seeks to change the term of members to provide better continuity and to reflect the current change in the International Union's selection of personal members or members-at-large.

Special CIOS Award. The Executive Committee endorsed in principle the plan presented by the Council for International Progress in Management (USA), Inc. (CIPM), to request CIOS to create a special award to recognize and encourage accomplishments in management at the international level by young executives, consultants, and educators. The plan involves no financial commitment on the part of ASME.

Engineers Joint Council. E. J. Kates, an ASME representative on EJC, reported on some items which had received the attention of the EJC Board of Directors. All EJC Societies have been invited to nominate members of an exploratory group on National Transportation Policy, and an exploratory group on Automation has been established. Incorporation of EJC became effective July 10, 1958, and the new constitution has been approved by the required number of participating societies.

Committee to Review EJC. The ASME Committee to Review EJC continued its study of EJC and the Functional Plan and reported to the President, Aug. 18, 1958. The report was sent to all members of the Council with a letter ballot on August 22. The Executive Committee approved the report and instructed ASME representatives to EJC and ECPD to promote implementation of the recommendations made by the ASME Committee to Review EJC.

United Engineering Center. W. F. Thompson, ASME representative on UET and chairman of the UET Real Estate Committee, reported on the current status of the United Engineering Center and the fund-raising campaigns. The property on United Nations Plaza has been purchased and cleared, except for the service station and the adjoining tenement. Architects have prepared preliminary plans. If sufficient funds are pledged, UET proposes to begin excavations and foundations on Jan. 5, 1959. As of Sept. 2, 1958, a total of $415,029 in 2756 member pledges has been reported from ASCE, AIME, ASME, AIEE, AIChE, and other societies. Mr. Thompson said that the weekly average pledges received from members in the five Founder Societies, is less than 25 per cent of what must be received in the remaining 17 weeks if the $3 million goal is to be achieved by the end of the year.

Deaths. The following deaths were reported: William F. Durand, past-president and Hon. Mem., Aug. 9, 1958. George B. Pegram, Fellow ASME, Aug. 12, 1958. Ford L. Wilkinson, vice-president 1943–1945, and Fellow ASME, Sept. 1, 1958.

Smithsonian Institution. The Secretary reported that John Fritz's "hook tool" had been given to the Smithsonian Institution for its Hall of Tools Exhibit.

Certificates of Award. The following certificates of award were approved: A. H. Hines, Region IV Sections Committee and M. E. Kirkpatrick, Region IV Student Section Committee. Retiring Chairmen of Sections: Louis E. Bunts, Akron; James A. Flint, Columbus; Willard E. Green, St. Joseph Valley; C. C. Eich, Chattanooga; Thomas O. Ott, Jr., Greenville; D. H. Kimball, Florida; Thomas W. Hegler, Miami; Herbert Kuenzel, Birmingham; John Stevenson, North Texas; Ralph Muller, Baltimore; John C. Fench, Peninsula Subsection of Virginia Section; Richard E. Ely, North Alabama Subsection of Birmingham Section; Eugene Deas, Richmond Area Subsection of Virginia Section; and C. E. Youngblood, Johnstown Group of Westmoreland Section.

A certificate also was voted to John S. Rearick, Petroleum Division.

Appointments. The following presidential appointments were reported:

W. H. Byrne, to fill unexpired term of C. E. Crede, Executive Committee of the Council.

William H. Larkin, Annual Meeting, NCSBEE, Aug. 21–23, 1955, Milwaukee.

J. W. Barker, W. H. Byrne, Ernest Hartford, T. A. Marshall, Jr., and J. W. Wheeler, honorary vice-presidents for funeral services of William F. Durand, Brooklyn, N. Y., Aug. 13, 1958.

D. R. Yarnall and R. S. Wilbur, honorary vice-presidents for funeral services of George B. Pegram, Aug. 14, 1958.

George Browne, official delegate, UPADI Conference, Sept. 26, 1958, Montreal, Que., Canada.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC [Agency]

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

NEW YORK	CHICAGO	DETROIT	SAN FRANCISCO
8 West 40 St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Chief Engineer, MSME; registered; 23 years' experience; interested in, adaptable to, present and future needs and problems. Creative in the fields of new products, exploitation of the separate accomplishments of design, development, and research. Covers light to heavy mechanical equipment, appliances, weapons, etc. Me-647.

Mechanical Engineer, BS(ME), PE Mich.; 44; 18 years in automotive, rubber, and electroforming manufacturing and development activities as development and cost engineer. Technical and economic evaluation of products, processes, and equipment. Prefers Midwest. Me-648.

Mechanical Engineer, BS, MS; 47; two years college teaching; five years aircraft-controls design and liaison; 19 months general mechanical engineer with the Navy; RPE Hawaii. Prefers southern Calif. Me-649.

Manager, R&D; Laboratory Director; Chief Engineer; BSME, MSME, PE; 35; eight years r&d in chemical-process design, product improvement, unit operations, pilot-plant operation, plant start-ups; three years nuclear reactor design; thorough knowledge of heat transfer, hydraulics, testing. Prefers 100-mile radius of New York City. Me-650.

Plant Manager, BSME.; 44; 20 years' broad experience in Europe, Canada, U. S. A. planning design, construction, installation, over-all management of chemical, armaments, explosives, machine tool, aircraft, wood products, and foam-materials plants. Successful assignment record. Location optional. Me-651.

Design-Development Engineering Supervisor or Management Engineer, BSME; 40; abilities and interests center upon design-development of useful labor and cost-saving machinery. Fourteen years' technical experience six of which were in supervisory position. Business education and experience fit for management. Special experience in pneumatic-hydraulics, one patent. Prefers Chicago, Midwest, West Coast. Me-652-909-Chicago.

Mechanical Engineer, BSME, PE; 36; ten years' design and project experience in mechanical and chemical plant and equipment. Excellent background, record, leadership, versatility, professional competence. Responsible position only. Prefers Cleveland, San Francisco, or equal. Me-653.

Plant Engineer, BS (ME); 28; five years' varied industrial experience. Design installation, and maintenance of plant equipment and process machinery. Cost-conscious engineer with ability to follow through. Location optional. Me-654.

Mechanical Engineer, BSME, PE; 30, single. Seven years with same petrochemical company in design, maintenance, now power engineer over all utilities operations. Diversified and adaptable. Desires foreign experience as project engineer or supervisor-organizer. Short term also acceptable for surveys, reports, or traveling. Me-655.

Manufacturing Executive, BME, LLB; 43; 13 years' experience in line manufacturing positions in metalworking field including plant management. Experience covers machining, forming, welding, assembly, plating, etc. Prefers Midwest or East. Me-656.

[1] All men listed hold some form of ASME membership.

Positions Available

Designer-Draftsman, two to five years' experience in regulating and control-valve equipment. Operating experience with automatic control valves, pneumatic instruments, diaphragm-control valves, and pressure regulators is desirable. Salary open. Apply by letter giving complete details including salary requirements. Upstate N. Y. W-6527.

Manufacturing Trainee, Methods, BSME or BSIE, graduate degree in BA, ME, or IE desirable; one to two years' experience in methods, manufacturing, or tooling techniques desirable; however, emphasis will be placed on applicant's potential. Will be placed in methods department-analyzing and developing production, and tooling requirements and techniques. $6000–$7800. Company will negotiate placement fee and relocation expenses. Upstate N. Y. W-6541.

Account Executive, Sales, BSME or BSEE desired; BSBA acceptable, graduate work desired; one to two years' experience in sales correspondence or contract administration necessary. Familiarity with aircraft components and hydraulics helpful. Position will involve administration of many technical contracts with a large amount of correspondence, liaison, and follow-up work needed. Will lead to outside technical sales in short time. No travel involved. $7020. Company will negotiate placement fee and relocation expenses. Upstate N. Y. W-6542.

Factory Engineer, graduate industrial or mechanical, one to three years' experience in processing methods or allied fields. Will plan and prepare process sheets, including time estimates for standard cost, for sub and final assemblies on new products and cost-reduction programs including brazing, welding, wiring, painting, metal finishing, and mechanical assembly. $6500–$8000. Upstate N. Y. W-6545.

Commercial and Production Manager for small paper-conversion plant. Apply by letter giving information about past experience, references, and salary requirements. Latin America. F-6548.

Manager, Newspaper-Automation Equipment, graduate mechanical engineer, successful experience as production head of a large newspaper or other publishing organization or as head of sales and/or engineering of printing and publishing or related equipment; successful general management experience. Must be able to direct the design, product development, and systems engineering of publishing automation or related equipment. $20,000–$25,000, plus incentive. Midwest. W-6551.

Quality-Control Engineer, mechanical or electrical graduate, five to ten years' instrumentation experience including design, testing, and inspection of control instruments. Considerable specification and nondestructive testing required. Must be free to travel. $7200–$8400. Company pays placement fee, relocation expenses; other fringe benefits. Pa. W-6561.

Engineers. (*a*) Plant industrial engineer, engineering degree, to head up industrial-engineering activities at plant level. Tool and die experience is desirable as well as experience in establishing labor standards by time-study and improving methods. $7800–$9000. (*b*) General foreman, plant, and equipment maintenance, graduate mechanical, some tooling background or IE with ME option. Assignment consists of plant engineering and the set-up, operation, and maintenance of specially designed production machines and equipment. $5400–$8580. Pa. 6570.

Assistant Plant Engineer, graduate mechanical. Must be thoroughly familiar with building construction, steam boilers, evaporators, refrigeration, drafting equipment, construction and erection, and efficient plant layout. Must have had about five years' experience in specialized design of machines required in all departments of food-processing industry. $12,000, or better, depending on qualifications. Company will pay placement fee. Eastern Pa. W-6573.

Industrial Engineer, thoroughly familiar with time study, methods, job evaluation, etc., for consulting engineers' office. Initial assignment on cargo handling. Little travel. $9600. Washington, D. C. W-6575.

Plant Engineer, graduate mechanical, experienced in labor-saving devices in the light indus-

tries. Three to five years' experience required; must have administrative ability as it will be necessary to supervise a group of draftsmen and other personnel. $8000, or better. Conn. W-6584.

Manufacturing-Engineering Supervisor to co-ordinate and supervise an effective manufacturing-engineering program designed to translate engineering design and drawings into a sound tooling and manufacturing program, for a machinery manufacturer. Will analyze engineering drawings of proposed products or changes in existing products, direct the activities of production engineers and tool designers, establish and maintain a complete tooling program, etc. Around $8000. Upstate N. Y. W-6585.

Chief Engineer, Special Projects, graduate mechanical, background in test facilities, design of jet engines, or a specialist in thermodynamics. Some direct experience in a missile program desired. Must have administrative ability. Will report to vice-president. $17,000–$20,000. New York, N. Y. W-6593.

Director of Engineering, graduate mechanical, to assume complete responsibility for all engineering work including design, specification and test, product development, supervision of engineering personnel, co-ordination with manufacturing subcontractor, and work with sales personnel and customers on engineering problems. Work will include dragline carts, conveyers, trailers, materials-handling equipment, etc. $8000. Pa. W-6594.

Industrial Engineer, mechanical or industrial graduate, six to ten years' experience in standard costs, work measurement, production methods, time studies, and controls. $10,000–$11,000. Considerable travel. Headquarters, New York, N. Y. W-6597.

Foreign Operations Manager, mechanical graduate, management, manufacturing, and product-application experience in domestic and foreign fields covering equipment and accessories for steam-power plants and process industries. $15,000. Pa. W-6598.

Project-Development Specialist, mechanical or industrial-engineering graduate, preferably with master's degree in business or marketing and experience in management, sales promotion, and application of industrial processes and products. Salary open. Midwest. W-6599.

Transactor District Specialist, college background or equivalent in liberal arts, accounting, marketing, or engineering, minimum of four years' successful office-equipment industry experience, systems-sales, or field-technical work, particularly punched card, computer, and integrated data-processing communications, field-technical sales, or supervisory experience. Experience in selling and actually installing comprehensive computer or punched-card production control, inventory, and payroll applications is highly desirable. Will co-ordinate activities pertaining to transactor sales within territory. $7500–$8500. Company pays placement fee. Extensive travel; must be willing to locate in Chicago, New York, Los Angeles, or Conn. Headquarters, Conn. W-6607.

Assistant to Product-Planning Manager, graduate mechanical or electrical with courses in design, production planning and control, accounting and economics; minimum of six years' manufacturing experience, preferably in office equipment or allied industry; minimum of four years' co-ordinating and expediting experience; technical report and instruction writing experience is essential. $8000–$10,000. Company will pay placement fee. Conn. W-6608.

Plant Engineer, for a pulp-paper mill making corrugated medium, kraft sheets and various unbleached hardboards, with capacity in the order of 100 tons per day. Will be responsible for the operation of two small package boilers (no power), water treatment, and mill maintenance, which includes electrical and instrument as well as mechanical work. Caribbean area. F-6609.

Project Engineer, BS in mechanical or electrical engineering, five years' industrial experience in one or more of the following areas: Machine design, automatic machines, and/or packaging machines. $8500. N. J. W-6619.

Engineers. (*a*) Senior manufacturing engineer, mechanical graduate, experience in the furnace brazing of aluminum and stainless steel, on tooling and tool design on fixtures and positioners for welding and assembly. (*b*) Intermediate engineer with similar experience. Salary open. Wis. W-6626.

Project-Plant Engineer, mechanical graduate, approximately five years' experience as project engineer or plant engineer in the paper-converting or boxmaking industry. Will recommend material-handling equipment, install new equipment, handle waste disposal, etc. To $9000. Ohio. W-6629.

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME FIRST NAME MIDDLE NAME

POSITION TITLE NATURE OF WORK DONE

e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) Division, if any

* ☐

EMPLOYER'S ADDRESS City Zone State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g. Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

* ☐

HOME ADDRESS City Zone State

☐

PRIOR HOME ADDRESS City Zone State

* CHECK "FOR MAIL" ADDRESS

I subscribe to

	Address changes effective when received prior to:
☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ U—Maintenance and Plant Engineering
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	
	☐ R—Railroad	

Research Project Engineer, graduate mechanical; will be responsible for broad program in engineering research and development including products, machines, and processes; direct necessary research activities, experimental testing, and such mechanical engineering as is necessary to prove theories to be incorporated in design; prepare specifications and preliminary drawings, etc. $7800–$9880. Pa. W-6634.

Sales Management for a manufacturer of heat-transfer equipment. (*a*) Sales manager for ventilating, heating, and cooling division. Excellent possibilities for promotion. Salary good. (*b*) General sales manager to supervise entire sales department. Position carries title of vice-president. Excellent opportunity for promotion. All applicants must be strongly sales minded and capable of administering a sales department. (*c*) Sales engineers also required. Experience in the heat-transfer equipment field required. Headquarters, Midwest. W-6635.

Product Designer, graduate, five to ten years' experience in product design of small electromechanical devices. Will be in charge of special project redesigning small electric motors and consumer-household products. $9000–$10,000. Conn. W-6637.

Recent Graduate Trainees in industrial engineering for large consumer goods manufacturer. Mechanical or industrial-engineering degree. $5400–$5700. Either Conn. or Mass. plants. W-6639.

Market-Research Engineer, BSME or BSEE, minimum of two years' sales engineering or marketing experience; technical product-promotion experience. Experience in selling electronic, hydraulic, or pneumatic instruments, automatic controls, or test equipment highly desirable. Will be responsible for gathering and analyzing data relative to existing and potential military and commercial markets. About $10,000–$12,000, and profit sharing. Agency fees and relocation expenses will be negotiated. N. Y. State. W-6649.

Engineers. (*a*) Director of engineering for Instrument Division of company engaged in design and manufacture of potentiometer-type instruments and related electromechanical components. Graduate mechanical engineer, advanced degree desirable, with a minimum of ten years' progressively responsible engineering experience in instrumentation or a closely allied field, three years of which were at the chief engineer level, or equivalent. Will be responsible for the direction and co-ordination of all engineering functions and activities including research, design, and development. To $18,000. (*b*) Division manager, degree in engineering, an advanced degree in business administration desirable, minimum of ten years' progressively responsible experience in technical sales, production, or engineering, plus at least three years at the overall management level; at least three years must have been in instrumentation or a closely allied industry. Will plan, staff, organize, direct, control and co-ordinate all sales, engineering, production, and quality-control activities; responsible for new instrument designs, effective production of high-quality products at economical cost, and an optimum volume of orders. To $20,000. Company pays placement fees and relocation expenses. West Coast. W-6653.

Engineers. (*a*) Chief engineer, graduate, good background in supervising design and project-engineering activities for a company engaged in design and manufacture of potentiometer-type instruments and related electromechanical components. To $12,000. Midwest. (*b*) Engineers, graduates, for opportunities in sales, production, test, and design engineering, for above company. To $8000. Company pays placement fees and relocation expenses. Midwest and West Coast. W-6654.

Administrative Executive, mechanical graduate, to take charge of the production and industrial engineering for a process industry including maintenance. Knowledge of costs and labor relations desirable. Will become either factory manager or vice-president of production. About $15,000. New York, N. Y. W-6657.

Product-Development Engineer to design, develop, write specifications for metal partitions, wall panels, library shelving. Will report to vice-president of sales. $10,000–$12,000. South. W-6658.

Chief Product-Development Engineer, graduate mechanical, five years' experience in product development and design; know hydraulics. Will supervise small engineering department of seven designers and draftsmen on medium-size valves and fittings. Must be good creative thinker with a minimum of five patents. $12,000–$15,000. Employer will pay placement fee. Southwest side of Chicago, Ill. C-7017.

Sales Manager, graduate engineer, preferably mechanical; must have successful sales management experience in automated electronics production line equipment including conveyers, feeders, hoppers, machine controls, inspection equipment, and gages to the automotive and related industries. Must be good supervisor and planner of sales and advertising programs. Able to work with production personnel such as plant managers, methods and process engineers, for a manufacturer of electronic automation equipment. $15,000–$20,000. Midwest. C-7022.

Chief Product Engineer, graduate mechanical; experienced in product design. Will supervise engineering department of about 18; responsible for product design and development of construction equipment such as compacters, power trowels, concrete vibrators, and finishing screens and space heaters used by construction industry for drying and heating. $12,000–$20,000, depending upon experience. Employer will pay placement fee. Midwest. C-7024.

Plant-Operating Engineer. (*a*) Senior; (*b*) Junior. Graduate mechanical engineers, minimum of 12 years' experience for the Senior and five years' for the Junior, setting up and operating industrial plants, preferably consumer goods. Will work with group on architectural and engineering professional services. Must be able to job train native technical and administrative talent; have appreciation for underdeveloped native cultures and races. Apply by letter. Additional housing allowance for dependents. One-year contract, possible extension. (*a*) $11,000, (*b*) $9000. Far East. S-3839.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

The application of each of the candidates listed below is to be voted on after Nov. 25, 1958, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and •Transfers

Alabama

Jordan, William D., University

Arizona

Leonard, Oliver G., Phoenix

Arkansas

Heroman, William L., Arsenal
Holt, George R., Jr., Pine Bluff

California

•Brous, Chris J., Canoga Park
•Brush, Don O., Sunnyvale
Foote, Alvin L., Santa Paula
Hornbuckle, Jim D., Temple City
Ingram, Thomas J., Pasadena
MacDonald, Frederic R., Granada Hills
Moloney, Desmond P., Los Angeles
•Nichols, John B., Atherton
Sakuma, Sadao, Los Angeles
•Toda, Roy T., Los Angeles
Webb, Robert C., Manhattan Beach
Winkler, Wojciech A., Hayward
•Witten, Wesley M., Bakersfield

Connecticut

•Fox, Lloyd, Sandy Hook
Rankin, Bruce H., Mystic

District of Columbia

Longhurst, Howard R., Washington
Nicolson, Charles W., Washington

•Transfer to Member or Affiliate.

Florida

•Johnson, Benjamin W., Bartow
Thomas, Jack L., Riviera Beach

Georgia

Henderson, Hugh T., Hampton

Hawaii

Broiles, Arthur W., Honolulu
Lee, Stimson S. T., Honolulu
MacLaren, Douglas B., Honolulu

Illinois

•Hirst, Harry, Jr., Chicago
Hwang, Chung M., Chicago
Power, Jack D., Chicago
•Schneider, Raymond C., Rockford
•Taylor, Charles E., Urbana

Indiana

Mercer, Robert H., Whiting
•Olson, Norman R., Highland

Iowa

Beckett, Royce E., Iowa City
Peterson, Jimmie G., Muscatine

Kansas

•Schmall, Henry H., Kansas City
Schulte, Arthur J., Topeka

Louisiana

Horton, John L., Shreveport

Maryland

Delson, Erwin B., Bethesda
Perkins, Oris C., Jr., Towson
Posnakoff, John, Baltimore

Massachusetts

Carlson, Wendell C., Wayland
FitzGerald, Frederick M., Hopedale
•Glaser, Peter E., Somerville
Koines, Nicholas P., Brockton
Margolskee, Justin M., Waltham
McCormick, Thomas J., Springfield
Nelson, Frederick C., Medford
•Wiseman, Elton J., Waban

Michigan

McLean, Wesley, Farmington
•Nichols, D. Edward, Midland
Ross, Howard R., Royal Oak

Missouri

Beckerle, Harry L., Kansas City
Carney, John J., St. Louis
•Johnson, Daniel C., Kansas City
•Seelig, Albert F., Jr., St. Louis

Nebraska

McConkle, Charles C., Jr., Omaha
•Reis, Irvin L., Lincoln

New Hampshire

Bunting, James J., Bedford

New Jersey

Carter, Arthur J., Jr., E. Paterson
Chen, Charles S. Y., Somerville
Ehling, Ernest H., Springfield
Evans, John J., Jr., Scotch Plains
Furney, Charles P., Jr., Garwood
Hess, Walter J., East Paterson
•Kleiner, Fred W., Leonia
McGlew, John J., Hasbrouck Heights
•Rigassio, James L., North Bergen

New Mexico

•Dove, Richard C., Albuquerque

New York

Adelberg, Marvin, Brooklyn
Blakis, Rudolfs, Olean
Boley, Bruno A., New York
•Breugelmans, A. Julien, New York
•Cohn, Franklin M., Glen Cove
Del Cano, Camilo P., Owego
•DiMaggio, Samuel S., Penfield
•DuPont, Frank M., North Bellmore, L. I.
Engel, Frederick C., Scarsdale
Gispan, Jonathan, Utica
Johnson, Eric W., Endicott
Kelsey, Robert J., New York
Prince, Thomas F., Sidney
Przybycien, William M., Schenectady
Raffaelli, Gaston L., New York
•Rosenthal, Paul, Buffalo

●SHETTLER, WILLIAM F., Ballston Lake
STUDENT, JOSEPH J., Owego
TAFT, WILLIAM K., Niagara Falls
WATKINS, GEORGE E., Corning
WIESENTHAL, PETER V., New York

North Carolina

CONRAD, LUCAS J., Winston-Salem
GROVER, ELLIOT B., Raleigh
NORMAN, WILLIAM R., Charlotte

Ohio

●CARNAVOS, THEODORE C., Massillon
GOODWILLER, ELBERT V., Dayton
HABER, LYLE E., Cleveland
MACINNES, HUGH, Willoughby
ROSS, ARTHUR L., Cincinnati
WEINSTEIN, JERRY L., Alliance

Oklahoma

●SHARP, HOWARD R., Bartlesville
WHEATLEY, CHARLES, Tulsa

Oregon

●CORDER, STANLEY E., Corvallis

Pennsylvania

CULLEN, WALLACE J., Scranton
DEAK, GEDEON I., Bethlehem
HEATON, GEORGE L., Carnegie
HOLT, SHERWOOD G., Landenburg
JHA, ASU R., Philadelphia
POLIS, ALBERT S., Philadelphia
SINGH, BILL, Allentown
SOKOLOWSKI, PETER F., Springfield
TALLIAN, TIBOR E., Philadelphia

South Carolina

ECKARDT, EUGENE P., Aiken

Tennessee

MCCOLL, ALLAN C., Chattanooga

Texas

BULTZO, CHARLES, Baytown
MILLER, TERRELL V., Houston
PURNELL, WILLIAM B., Houston
●RAMSDELL, WILLIAM H., Houston
STEPHENSON, DALE Q., Dallas
TOMLINSON, LESLIE N., San Antonio
WENK, EDWARD, JR., San Antonio

Virginia

BRAUN, ROBERT O., Falls Church
●CALDWELL, LAWRENCE C., JR., Richmond
TAYLOR, ARTHUR C., JR., Lexington

Washington

●CODY, FREMONT R., Tacoma
MASSENA, WILLIAM A., Richland

Wisconsin

SELBY, WILLIAM A., La Crosse

Foreign

AGUIRRE, GUILLERMO A., Mexico, D.F., Mexico
ANDREWS, ARTHUR, Ottawa, Ont., Canada
GHOSH, TAPAS K., Birmingham, England
HEBERT, GILES J., Cap de la Madeleine, P.Q., Canada
●POWELL, GEORGE G., Oakville, Ont, Canada
SMITH, ARTHUR E., Welland, Ont., Canada
SOLAN, ALEXANDER, Rehovoth, Israel

OBITUARIES

Charles William Beese (1891–1958), dean, Division of General Extension, Purdue University, Lafayette, Ind., died June 29, 1958. Born, Des Moines, Iowa, April 2, 1891. Parents, George and Sarah (McCully) Beese. Education, BS (ME), Iowa State College, 1915; MS, 1923. Married Ione Johnstone, 1917; one daughter, Betty. Mem. ASME, 1938. Dean Beese had been on the staff at Purdue since 1937. He had previously been an instructor at Iowa State College; professor at Pennsylvania State University; and industrial engineer at Armstrong Cork Co. During World War I, he served in the U. S. Army Engineer Corps. Dean Beese had been a specialist in manufacturing management and technical institute education. In 1953, he received the fourth annual James H. McGraw Award in Technical Institute Education. He was the author of a number of papers on engineering education and management. His services to the Society included membership on the Executive Committee and the General Committee of the Management Division. He was a member also of ASEE, SPEE, and Tau Beta Pi. He was a registered professional engineer in the States of Pennsylvania and Indiana.

Major Manoel F. de Mayo Behar (1889–1958), retired vice-president, Instruments Publishing Company, and editor emeritus of *Instruments and Automation*, died Aug. 1, 1958, while attending the Gordon Research Conference at Colby Junior College, New London, N. H. Born, Jerusalem in the Middle East, Feb. 7, 1889. Education, private schools in France, Switzerland, and England; Pratt Institute; and Columbia University. Married Sara R. Pattin. Assoc-Mem. ASME, 1920; Mem. ASME, 1927. Major Behar, an internationally known figure in the fields of automation and instrumentation, wrote and edited the early literature in those fields. As an officer in U.S. Army Ordnance, during World War I and in the reserve, he invented several military instruments. As editor of *Instruments*, Major Behar devoted his efforts to formulating the science of instrumentation, and it was he who in 1924 adopted the term "instrumentation" to denote the unwritten science. His article, "Regulation, Automatic," in the 1929 edition of "Encyclopedia Britannica" appears in the 1958 edition without change. In 1927, he wrote the chapter on Industrial Instruments for "Rogers' Manual of Industrial Chemistry." From 1930 to 1936 a series written for *Instruments* by Major Behar constituted the first formulation of the science of instrumentation. Major Behar served the Society as secretary of the National Defense Division from 1923 to 1926; helped found the Instruments and Regulators Division; and was first chairman of the Automatic Control Terminology Committee. He was an honorary member of the Instrument Society of America which was formed partly as a result of his efforts with instrument-engineer groups in several industrial centers throughout the country. He was a fellow of AAAS and a member of numerous other societies. Earlier this year he received the Pratt Institute Alumni Medal in recognition of his support of the school's alumni. Survived by his widow.

William Herbert Billich (1900–1958), manager, Washington office, Combustion Engineering, Inc., Washington, D. C., died August 13, 1958. Born, Allentown, Pa., Sept. 25, 1900. Parents, Daniel T. and Sarah H. J. Billich. Education, high-school graduate; ICS. Married Mildred Anna Kauffman, 1927. Assoc-Mem. ASME, 1928. Mr. Billich joined Combustion Engineering in 1944 as Washington representative of its Export Division. In the period 1947–1951 he was assigned to the company's Brazil sales office, and in 1953 he became manager of the Washington office. Previously, he had been with Gilbert Associates, Inc., Reading, Pa.; and in 1942–1944 with the Office of Lend-Lease Administration and the Foreign Economic Administration. He served the Society as Secretary of the Reading, Pa., Division of the Anthracite-Lehigh Valley Section in 1934–1935. Survived by his widow, and one daughter, Mrs. Woodbury Johnson.

John William Chadwick (1881–1958), retired sales division engineer, National Supply Co., Casper, Wyo., died Aug. 8, 1958, in Glendale, Calif. Born, Clifton, Kan., Nov. 19, 1881. Parents, John W. and Sarah C. (Baker) Chadwick. Education, attended engineering school, Kansas University. Married Ida M. Katherman, 1905. Mem. ASME, 1948. Mr. Chadwick had been a specialist in the natural gas industry. Survived by a son, Donald W. Chadwick.

George Cook, Jr. (1898–1957), assistant chief draftsman, Day & Zimmerman, Inc., Philadelphia, Pa., died Nov. 4, 1957. Born, Philadelphia, Pa., May 16, 1898. Parents, George and Elizabeth (Huthmacher) Cook. Education, attended Franklin Institute; ICS. Married Barbara Berryman, 1919. Jun. ASME, 1924; Assoc-Mem. ASME, 1926; Mem. ASME, 1930. Mr. Cook had been a specialist in the design of power plants. Survived by his widow.

Bernard Crocker, Jr. (1908–1958?), whose death recently was reported to the Society, had been a consulting engineer, Raleigh, N. C. Born, Goldsboro, N. C., Feb. 25, 1908. Education, BS, North Carolina State College, 1930. Mem. ASME, 1950. Mr. Crocker had been in private consulting practice since 1936 with the exception of his period of service in the U. S. Army during World War II. He was a registered professional engineer in the State of North Carolina.

William Frederick Durand (1859–1958), past-president and Honorary Member of ASME, marine engineer, teacher, aeronautical researcher, "dean of American engineers," died Aug. 9, 1958, in New York, N. Y. Born, Beacon Falls, Conn., March 5, 1859. Parents, William Leavenworth and Ruth (Coe) Durand. Education, U. S. Naval Academy, 1880; PhD, Lafayette College, 1888; LLD, University of California, 1927. Married Charlotte Kneen, 1883 (d. 1950). Mem. ASME, 1883; Hon. Mem. ASME, 1934. Dr. Durand had been a pioneer in fluid dynamics and aeronautical research. His contributions in these areas spanned three quarters of a century. From 1880 to 1887 he served in the U. S. Navy Engineering Corps. He was on the faculty at Michigan A & M College as professor of mechanical engineering from 1888–1891. He was professor of marine engineering at Cornell University in 1891 remaining until 1904. He then went to Leland Stanford University as professor of mechanical engineering until 1924 when he reached the age of retirement. At that time he was elected president of ASME and devoted all of his time to that office. From 1925 to 1930 he was a trustee of the Guggenheim Fund for the Promotion of Aeronautics. During World War I, Dr. Durand served as scientific attaché to the U. S. Embassy in Paris. He was appointed by the President as one of the original members of the National Advisory Committee for Aeronautics and served the committee from 1915 to 1933, during World War I serving as its chairman. He rejoined the committee during World War II as a member of its Committee on Jet Propulsion. From 1915 to 1945 he was also a member of the National Research Council. In 1925 the President appointed him a member of the Morrow Board. In addition, he was a consultant in the design of the Hoover, Grand Coulee, and Shasta Dams. He was chairman of the Navy's special committee appointed to study the broad question of the lighter-than-air airship. His accomplishments were so extensive that it would be impossible to list here even the high lights; however, his published works are monuments to a vast career and have been authoritative sources for generations of students. He wrote the "Fundamental Principles of Mechanics," 1889; "Resistance and Propulsion of Ships," 1898; "Practical Marine Engineering," 1901; "Motor Boats," 1907; "Hydraulics of Pipe Lines," 1921; a "Biography of Robert Henry Thurston," 1929; and his autobiography, "Adventures—In the Navy, in Education, Science, Engineering, and in War." He conceived and was general editor of a definitive, six-volume study, "Aerodynamic Theory," 1934. In addition, he wrote many papers for ASME and other organizations. His honors are too numerous to list, but the following indicate their scope; Guggenheim Medal Award, 1935; John Fritz Medal award, 1935; Franklin Institute Medal Award, 1938; ASME Medallist, 1945; Presidential Award of Merit, 1946; Wright Memorial Trophy, 1948. He was the first American to deliver the Wilbur Wright lecture before the Royal Aeronautical Society of Great Britain. Dr. Durand gave long service to the Society. His participation on many committees led to his election as a vice-president in 1911–1913; and culminated in his election as president in 1924. He was a Fellow of the American Academy of Arts and Sciences, AAAS, Royal Aeronautical Society, Institute of Aeronautical Sciences; and a member of the National Academy of Sciences, the American Philosophical Society, SNAME, and numerous others. Survived by his son, William Leavenworth Durand; and two grandsons, William F. and John Leavenworth Durand. (*See also*, "Editorial," MECHANICAL ENGINEERING, October, 1958, pp. 51-52.)

William Rankine Eckart (1873–1958), consulting engineer and former professor at Stanford University, Pasadena, Calif., died July 14, 1958. Born, Marysville, Yuba County, Calif., May 25, 1873. Education, ME, Cornell University, 1895. Mem. ASME, 1904. Mr. Eckart had been a principal consulting engineer with C. F. Braun and Co., Alhambra, Calif., from 1927 to his retirement in 1945. Prior to that he had been a professor of mechanical engineering at Stanford for a quarter of a century. He attained nationwide prominence in the petroleum industry for his work in the fields of heat transfer and fluid flow. Survived by his daughter, Mrs. Nelson Mills, and three grandsons, Nelson, David, and Donald Mills, San Marino, Calif.

Howard Louis Fischer (1885–1958?), whose death recently was reported to the Society, had been an engineer and patent attorney with Brown & Bigelow, St. Paul, Minn. Born, St. Paul, Minn., May 12, 1885. Education, St. Paul Mechanical Arts College. Mem. ASME, 1930.

John Bernard Gardner (1904–1958), Tippetts, Abbett, McCarthy & Stratton, Engineers, San Francisco, Calif., died Feb. 27, 1958. Born, Cologne, Germany, 1904. Education, Staedtisches Gymnasium, 1923; Machinenbau Hochschule, 1926; Cogswell Polytechnical, 1941; and special courses at University of California and Stanford University. Naturalized U. S. citizen. Mr. Gardner had been with the above firm since 1950 in charge of the plumbing, fire-protection, and machinery division of the mechanical department.

Hamilton Garnsey, Jr. (1901–1958), vice-president and general manager, Gould Pumps, Inc., Seneca Falls, N. Y., died April 26, 1958. Born, Seneca Falls, N. Y., Sept. 1, 1901. Parents, Hamilton and Elizabeth (Guion) Garnsey. Education, ME, Cornell University, 1923. Married Katherine Pomeroy, 1932. Assoc-Mem. ASME, 1929; Mem. ASME, 1935. Mr. Garnsey had begun his career with Gould Pumps in 1923.

George Albert Hansen (1916–1958), steam engineer, engineering and service department, Westinghouse Electric Corp., Chicago, Ill., died June 2, 1958. Born, Chicago, Ill., July 16, 1916. Parents, H. Albert and Antonie G. Hansen. Education, BS(ME), University of Michigan, 1938. Married Virginia Weidlein, 1938; three children, Judy, George, Jr., and Sally. Assoc-Mem. ASME, 1944.

John Samuel Hedger (1910–1958), sales engineer, The Ohio Steel Foundry Co., Springfield, Ohio, died January, 1958. Born, Grand Forks, N. D., June 13, 1910. Education, ME, University of Cincinnati, 1933. Mem. ASME, 1952. He joined Ohio Steel Foundry in 1929 and remained in their service until his death with the exception of the years 1941–1945. During that period he served as a 1st lieutenant in the U. S. Army Ordnance Department and was honorably discharged with the rank of lt. colonel.

Ernest Caldwell Holdredge (1918–1958), professor and head of the mechanical engineering department, Lamar State College of Technology, Beaumont, Texas, died March 5, 1958. Born, Lenoir City, Tenn., Feb. 6, 1918. Education, BS(ME), University of Tennessee, 1941. Assoc. Mem. ASME, 1942. Mr. Holdredge served as the first head of the department of mechanical engineering at Lamar. He was active in local ASME activities serving in many capacities as well as on the Executive Committee of the Sabine Section.

John Richard Hunter (1878–1958?), whose death recently was made known to the Society had been a maintenance engineer, Goodyear Tire & Rubber Co., Akron, Ohio. Born, South Shields, Durham, England, Aug. 1, 1878. Parents, John and Hannah Hunter. Education, private schools of England; attended Rutherford College. Naturalized U. S. citizen, Akron, Ohio, 1915. Married Mary Evelyn; one daughter, Winifred. Assoc-Mem. ASME, 1918; Mem. ASME, 1935.

Louis Illmer (1878–1958), former patent attorney, instructor in gasoline-engine design, Cornell University, and developer of the Illmer two-stroke engine, died July 18, 1958. Born, St. Louis, Mo., July 19, 1878. Parents, Louis and Emmy Illmer. Education, ME, Cornell University, 1902; post-graduate study at Berlin Polytechnic, Germany. Married Winifred R. Rogers, 1906. Mem. ASME, 1913. Mr. Illmer held over 20 patents pertaining to oil and gas-engine developments, lubrication, and so on. He published numerous papers in the technical journals of ASME and other societies and in trade journals. Survived by two daughters, Elizabeth and Mrs. Alexander Forstythe.

John Gething Jones (1900–1958?), whose death recently was reported to the Society had been vice-president, general manager, and treasurer, A. W. Cash Co., Decatur, Ill. Born, Philadelphia, Pa., Aug. 4, 1900. Parents, Walter and Clara (Joseph) Jones. Education, Attended Carnegie Institute of Technology and Ohio State University; ICS. Married Eleanor Chambers, 1924. Mem. ASME, 1940. Mr. Jones had had an active career concerned mainly with process industries, management, and steam power. He was a registered professional engineer in the State of Ohio.

Eric A. Kerbey (1898–1958?), president, Midwest Piping Co., Inc., St. Louis, MO., died recently according to a report received by the Society. Born, Rogers City, Mich., Oct. 8, 1898. Parents, Frank E. and Marie (Turno) Kerbey. Education, BS(ME), University of Michigan, 1921. Married Elizabeth G. Bell, 1925. Assoc-Mem. ASME, 1930; Mem. ASME, 1935. Mr. Kerbey had been with Midwest Piping since 1928; he became its president in 1955. He was a member also of AWS and Tau Beta Pi.

Carl Frederick Kleck (1888–1958), combustion engineer, The Peoples Gas Light & Coke Co., Chicago, Ill., died May 11, 1958. Born, Milwaukee, Wis., July 18, 1888. Education, BS(ME), University of Wisconsin, 1914. Mem. ASME, 1950. A registered professional in the State of Illinois, Mr. Kleck was a specialist in the combustion of fuels and pertinent subjects. Survived by his widow.

Andrew Wilson Knecht, III (1932–1958), mechanical designer in office of chief engineer, American Home Products, New York, N. Y., died July 26, 1958. Born, Yonkers, N. Y., Dec. 23, 1932. Parents, A. Wilson (Mem. ASME) and Hilda B. Knecht. Education, BS(ME), Lehigh University, 1954. Until November, 1957, he had been a designer for Seelye, Stevenson, Value, & Knecht. Survived by his parents.

Clarence Conrad Lande (1905–1958), staff maintenance engineer, Kimberly-Clark Corp., Neenah, Wis., died April 13, 1958. Born, Minneapolis, Minn., May 30, 1905. Education, (BSCE), University of Minnesota, 1927. Mem. ASME, 1937. Mr. Lande had been with Kimberly-Clark since 1928 when he began as a draftsman and successively held posts as development engineer, assistant field engineer, field engineer, and staff maintenance engineer.

William Matthews Mapes (1894–1958), vice-president in charge of sales, Bridgwater Machine Co., Akron, Ohio, died April 20, 1958. Born, Middletown, N. Y., Nov. 23, 1894. Affiliate ASME, 1951. Mr. Mapes was associated with Goodyear Tire and Rubber Co., Seiberling Rubber Co., and the R. H. Freitag Mfg. Co. During the last 30 years of intimate contact with the rubber molding industry, his foresight aided many automotive tire producers to attain high standards of complicated design. Survived by his widow.

I. Newton Odell (1885–1958), retired general superintendent, Defender Photo Supply Co., Inc., Rochester, N. Y., died March 29, 1958. Born, Hilton, N. Y., June 30, 1885. Education, BS(EE), Purdue University, 1910. Mem. ASME, 1943. Mr. Odell joined Defender Photo Supply in 1919. He held five patents pertaining to photographic equipment. Survived by his widow.

Gerhardt Norman Patitz (1913–1958), assistant to first vice-president, The Fleischmann Distilling Corp., Peekskill, N.Y., died April 11, 1958. Born, Oak Park, Ill., Feb. 8, 1913. Education, BS, Massachusetts Institute of Technology, 1935. Assoc-Mem. ASME, 1936; Affiliate ASME, 1946. Mr. Patitz joined the Fleischmann Distilling Corp. in 1945 as plant manager. Prior to that he had been with Standard Brands, Inc., and with Foster Wheeler Corp. Survived by his widow.

George Braxton Pegram (1876–1958), vice-president emeritus, Columbia University, and pioneer nuclear physicist, died Aug. 12, 1958. Born Trinity, N. C., Oct. 24, 1876. Parents, William Howell and Emma (Craven) Pegram. Education, AB, Trinity College (now Duke), 1895; PhD, Columbia University, 1903; studied at University of Berlin and at Cambridge University as a Tyndall Fellow, 1907–1908. Married Florence Bement, 1909. Mem. ASME, 1928; Fellow ASME, 1950. Dr. Pegram joined the Columbia faculty as an assistant in 1900. He became an assistant professor of physics in 1909; associate professor in 1912; and in 1918 full professor. In 1917 was named acting dean of the School of Mines, Engineering and Chemistry at Columbia and in 1918 he became dean, a post which he held until 1930. The university called upon him to be dean of the Graduate Faculties in 1936. In this capacity he administered the affairs of Columbia's graduate school and assembled the group of scientists whose work was to lead to the atomic bomb. It was he who made the first contact with the U. S. Government, in March, 1939, which was to result in the establishment of the Manhattan Project. The world's first atomic pile was then established at Columbia in 1941, expanding beyond the limits of the Pupin Physics Laboratories, to the basement of Schermerhorn Hall, and finally to garages and apartment buildings in the area. When the U. S. entered the war the reactor program was moved to the University of Chicago. Dr. Pegram remained at Columbia and was made vice-chairman of the Central Advisory Committee to the Manhattan Engineering District. After the war, he was appointed to the first board of directors of the Oak Ridge (Tenn.) Institute of Nuclear Studies. He also helped to establish the Brookhaven (L.I.) National Laboratory. He served as chairman of the university's Committee on War Research during the war, and was chairman of the university's Committee on Government-Aided Research for ten years after the war. In 1948 Dr. Pegram was named vice-president of Columbia. He retired in 1950, but remained as special adviser to the President of the University, then General Eisenhower. Dr. Pegram, in addition to his organizational and administrative contributions to the atomic effort, made many scientific contributions. He made measurements of the size of the neutron and, with Dr. J. R. Dunning, Mem. ASME, invented a device for measuring the component parts of the atom and demonstrating the possibility of transmuting one element into another. He was honored on numerous occasions. He held honorary doctoral degrees from seven universities; and in October, 1957 received the first Karl Taylor Compton Gold Medal for distinguished service to physics. The medal was awarded to him by Prince Philip, Duke of Edinburgh, on behalf of the American Institute of Physics. He was active in many professional societies and was a past-president of the New York Academy of Sciences and the American Physical Society; and a past-chairman of the Anglo-Hellenic Bureau of Education. His service to ASME included membership on the Applied Mechanics Division. He served on its Executive Committee in 1928 and was its chairman in 1932. He was chairman, in 1933, of the Society's Metropolitan Section. He was a member also of the Professional Divisions Committee. Survived by his widow; and two sons, William Braxton Pegram, Mem. ASME, Swarthmore, Pa., and John Bement Pegram, Los Angeles, Calif. (*See also, "Editorial,"* MECHANICAL ENGINEERING, October, 1958, pp. 51–52.

Fred M. Pettingill (1893–1958), design engineer, Masonite Corp., Laurel, Miss., died June 28, 1958. Born, Auburn, Calif., March 21, 1893. Parents, Arthur M. and Stella C. (Harris) Pettingill. Education, ICS. Mem. ASME, 1928. Married Dona Mae Hosey, 1935. Mr. Pettingill had been a specialist in cane-sugar mill design, high-pressure hydraulic presses and equipment, dust collection, and industrial ventilation. Survived by his widow.

Claudius Peters (1875–1957), owner of firm, Claudius Peters Aktiengesellschaft, Hamburg, Germany, died Dec. 27, 1957. Born, Wesselburen, Germany, Oct. 2, 1875. Education, Technische Staatslehrenanstalten Hildburghansen. Mem. ASME, 1948. Mr. Peters had for many years been European manager for the firm of Fuller Lehigh and Co., and had been German representative for The Babcock & Wilcox Co., and the M. H. Detrick Co.

Barney Spencer Platt (1882–1958?), whose death recently was reported to the Society, had been superintendent of power and maintenance, Burroughs Corp., Detroit, Mich. Born, St. Clair County, Mich., Nov. 11, 1882. Education, Cass Technical High School and technical courses. Mem. ASME, 1944. Mr. Platt had been with Burroughs since 1918.

Joseph A. Polson (1877–1958), professor emeritus, University of Illinois, Urbana, Ill., died July 8, 1958. Born, Centerville, Iowa, March 20, 1877. Education, BS(ME), Purdue University, 1905; ME, 1911. Married Betsy C. Lee, 1906. Assoc-Mem. ASME, 1906; Mem. ASME, 1912. Mr. Polson had been professor of steam engineering at the University of Illinois from 1921 to 1951. He was the author of a text book, "Internal-Combustion Engines," 1933.

William Frederick Rahm (1881–1958), retired tool engineer, Burndy Engineering Co., New York, N. Y., died May 24, 1958. Born, Irvington, N. J., Nov. 8, 1881. Parents, Adolph and Blanche Rahm. Education, attended Newark Technical School (Newark College of Engineering); Cooper Union; and New York University. Married Theresa S. Hummel, 1917. Mem. ASME, 1938.

Van A. Reed, Jr. (1878–1958), formerly with Federal Engineering Co., Pittsburgh, Pa., died Aug. 8, 1958. Born, Pittsburgh, Pa., Dec. 4, 1878. Parents, Van A. and Mary J. Reed. Education, high-school graduate and special instruction in mathematics, mechanics, and mechanical drawing. Married Anna Boyd, 1904 (died 1945). He had been with Federal Engineering since 1904 and was a specialist in the design and construction of complete steam, gas, and electric power plants, and water works. Survived by daughter Miss Anne B. Reed.

George Harold Rhodes (1890–1958), formerly with the engineering department, National Biscuit Company, Torrance, Calif., died April 15, 1958. Born, Norwood, Mass., Oct. 18, 1890. Parents, Herbert and Alice N. Rhodes. Education, BS, Massachusetts Institute of Technology, 1912. Married May Renz, 1917. Assoc-Mem. ASME, 1913; Mem. ASME, 1925.

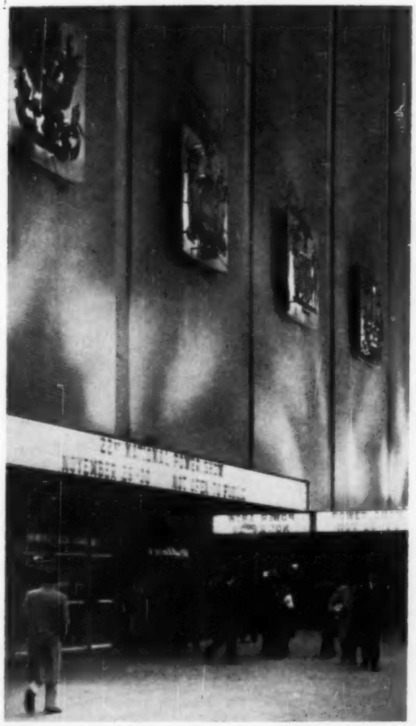
Herbert Asa Sawin (1894–1958?) whose death recently was reported to the Society had been assistant director of sales, Yuba Manufacturing Co., Benicia, Calif. Born, Springfield, Mass., March 5, 1894. Parents, Edwin Asa and Sarah Augusta Sawin. Education, attended Franklin Institute School. Married Mela Garrett; one daughter, Cynthia Lou Overmire. Assoc-Mem. ASME, 1930; Mem. ASME, 1935. Mr. Sawin had been with the Yuba Manufacturing Co. since 1922. He was a registered professional engineer in the State of California. Mr. Sawin was a past-chairman of the San Francisco Section of AIME.

David Ames Tripp (1914–1958), sales engineer, Research-Cottrell, Inc., Bound Brook, N. J., died June 5, 1958. Born, Somerville, Mass., Aug. 23, 1914. Education, BSE, Tufts College, 1936. Mem. ASME, 1952. Mr. Tripp had been with Research-Cottrell since 1940. During World War II he was officer in charge of the U. S. Marine Corps Radar School, Camp Lejeune, 1943–1944.

Charles Huntington Turner (1879–1958?), died recently according to a report received by the Society. He had been principal engineer with the Pullman-Standard Car Manufacturing Co., Worcester, Mass. He retired from that firm in 1947. Born, Fenton, Mich., March 1879. Education, studied mechanical engineering at the University of Minnesota for three years. Assoc-Mem. ASME, 1905; Mem. ASME, 1917.

William L. Uhde (1903–1958), Hyatt Roller Bearing Division, General Motors Corp., Harrison, N. J., died June 28, 1958. Born, Hamburg, Germany, March 29, 1903. Education, Dr. Jessel's Educational Institute, Hamburg, Germany; BS(ME), New York University, 1936. Naturalized U. S. citizen, Brooklyn, N. Y., 1931. Married Kathe Mattner, 1930. Mr. Uhde had been with Hyatt Roller Bearing since 1939. Survived by his widow; and a son, W. E. Uhde.

Clayton Wight Work (1892–1958), manager of sales promotion, Hagan Chemicals & Controls, Inc., Pittsburgh, Pa., died June 19, 1958. Born, Exeter, N. H., Sept. 27, 1892. Education, BS(ME), University of New Hampshire, 1913. Mem. ASME, 1950. A registered professional engineer in the State of Pennsylvania, he had been with the Hagan Corp., since 1924. During World War I, he served in the U. S. Navy.

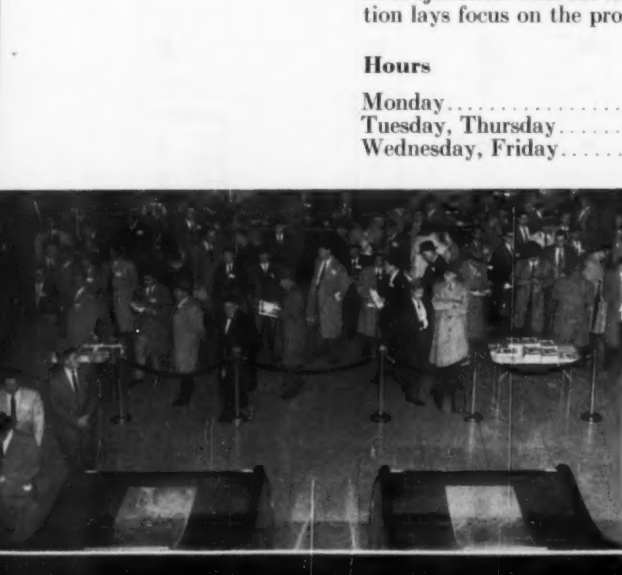


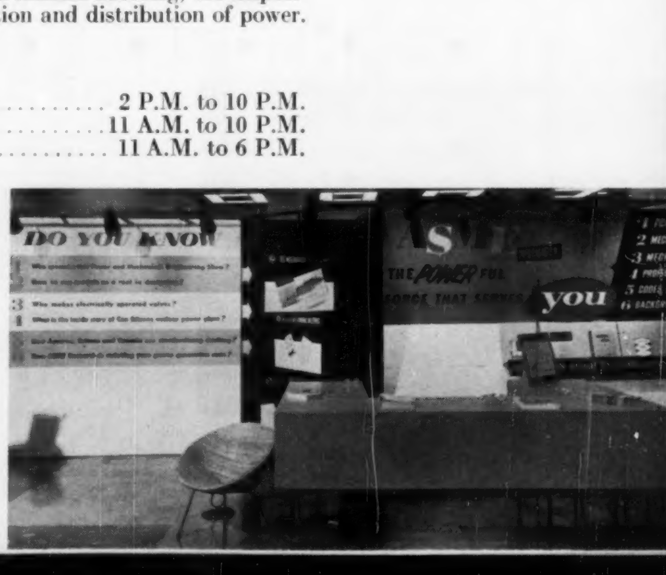
THE 23rd EXPOSITION OF POWER AND MECHANICAL ENGINEERING NEW YORK COLISEUM—DECEMBER 1-5

Forecasting the business expansion predicted for 1959 the 1958 Power Show lays stress on the methods and mechanisms whereby manufacturing industries will be able to increase productivity with economic advantage. Held under the auspices of The American Society of Mechanical Engineers, in conjunction with the ASME Annual Meeting, the Exposition lays focus on the production and distribution of power.

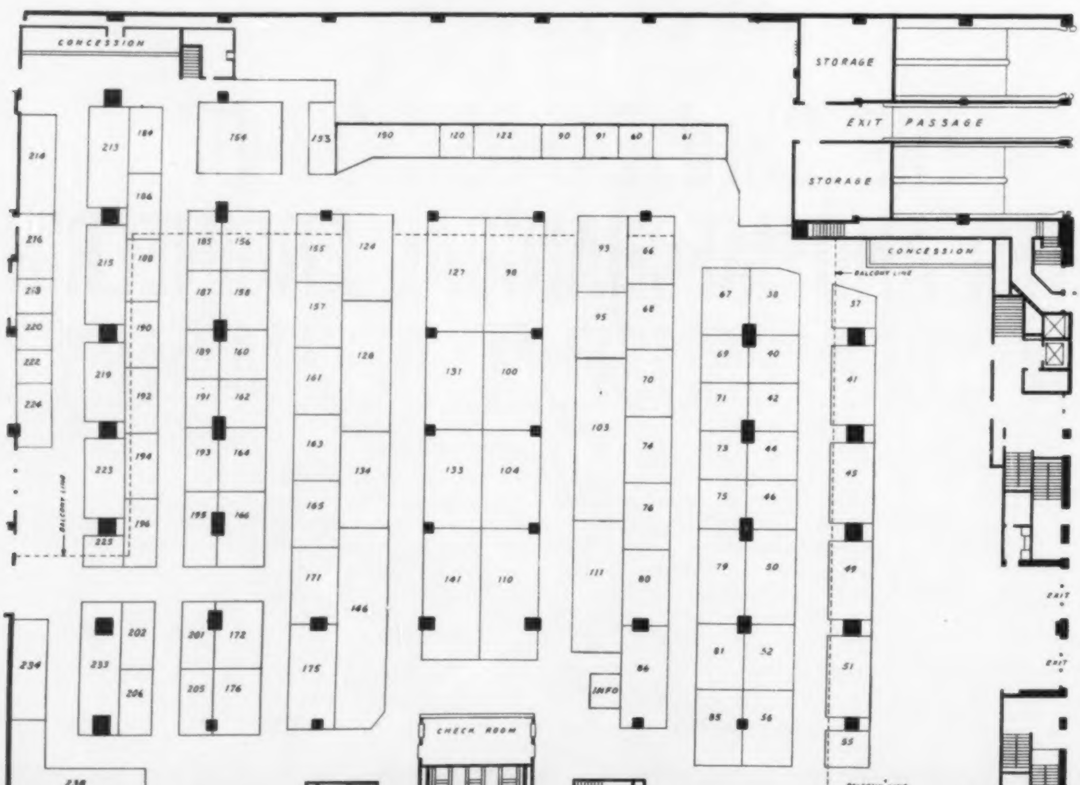
Hours

Monday	2 P.M. to 10 P.M.
Tuesday, Thursday	11 A.M. to 10 P.M.
Wednesday, Friday	11 A.M. to 6 P.M.





FIRST FLOOR PLAN OF EXHIBITORS



215 Abrams, Morris, Inc.
146 Allen-Bradley Co.
134 Allis Co., The Louis
75 American Hydrotherm Corp.
150 American Meter Co., Inc., Pump Div.
195 American Pullmax Co., Inc.
American Standard
  128 Kewanee Boiler Div.
  111 Ross Heat Exchange Div.
95 Anchor Packing Co., The
103 Barrett-Cravens Co.
223 Beaver Pipe Tools, Inc.
122 Biddle Co., James G.
175 Bituminous Coal Institute
175 Bituminous Coal Research, Inc.
51 Boston Gear Works
52, 56 Braun & Co., C. F.
216 Bruckner Machine & Tool Co.
216 Buck Manufacturing Co.
202 Byers Co., A. M.
46 Byron Jackson Div. of Borg-Warner Corp.
55 Carey Manufacturing Co., The Philip
172 Carpenter Steel Co., The, Alloy Tube Corp.
68 Chiksan Co.
171 Clayton Manufacturing Co.
212 Collins Machinery Corp.
157 Combustion Control Div., Electronics Corp. of America
215 Commander Manufacturing Co.
45 Curtiss-Wright Corp., Metal Processing Div., Research Div.
38 Utica Div., Curtiss-Wright Corp.
74 Dayton Rubber Co., The
215 Delta Equipment Co.
214 De Walt Div., American Machine & Foundry Co.
107 Diamond Core Drilling Co.
190 Diamond Expansion Bolt Co., Inc.
93 Diehl Manufacturing Co.
215 Dumore Co., The
157 Electronics Corp. of America, Combustion Control Div.
154 Eutectic Welding Alloys Corp.
81 Falstrom Co.
158 Flintkote Co., The, Van-Packer Co. Div.
131 Fluid Controls Company of New York
224 Foley Mfg. Co.
196 Furnas Electric Co.
124 General Fireproofing Co., The
219 Graham Machine Tool Co.
100 Green Fuel Economizer Co., Inc.
216 Heller & Sons, J.
160 Industrial Equipment News
60 Insto-Gas Corp.
175 International Boiler Works Co., The
70 International Research and Develop. Corp.
133 Jenkins Bros.
161 Keasbey & Mattison Co.
128 Kewanee Boiler Div. of American-Standard
162 Klemp Metal Grating Corp.
86 Leslie Co.
176 Mercoid Corp., The
98 Miller Fluid Power Div. & Tru Seal Div. of Flick Reedy Corp.
220 Milwaukee Electric Tool Corp.
185 New Hermes Engraving Machine Corp.
222 Nicholson File Co.
215 O'Neil Irwin Manufacturing Co.
131 P-K Industries, Inc.
131 Panellit Inc.
41 Permutit Co., Division of Pfaudler Permutit Inc.
141 Philadelphia Gear Corp.
44 Poole Foundry & Machine Co.
187 Portomag Inc.
66 Products Div., The, Globe Co.
163 Raybestos-Manhattan, Inc.
85 Research-Cottrell, Inc.
196 Ribble Co., C. H.
184, 186 Ridge Tool Co., The
60 Robinson, Inc., John R.
111 Ross Heat Exchanger Div. of American-Standard
67 Schaub Engrg. Co., Fred H.
127 Schrader's Son, A., Div. of Scovill Mfg. Co.
215 Sheldon Machine Co., Inc.
165 Sier-Bath Gear & Pump Co., Inc.
206 Spence Engineering Co., Inc.
120 Squires Co., The C. E.
164 Stephens-Adamson Mfg. Co.
90 Taylor Controls Corp.
160 Thomas' Register of American Manufacturers
166 Thompson-Ramo-Wooldridge Products Co.
194 Toledo Pipe Threading Machine Co.
158 Van-Packer Co. Div. of The Flintkote Co.
110 Vapor Heating Corp.
49 Velan Steam Specialties Inc.
104 Vogt Machine Co., Henry
201 Waldron Corp., John
187 Warner & Co., Inc., George W.
191 Wells Manufacturing Corp.
156 Wheeler Mfg. Co., C. H.
79 Wing Mfg., L. J., Div. of Aero Supply Mfg. Co., Inc.
50 York-Shipley, Inc. (Industrial Div.)

SECOND FLOOR PLAN OF EXHIBITORS

591 Aerco Corporation
424 Air Conditioning Equipment Corporation
660 Airetool Mfg. Co.
531 Allis-Chalmers Manufacturing Co.
668 Alloy Steel Products Company
569 American Air Filter Company
516, 520 American Brass Company
632 American Society of Mechanical Engineers
435 Anderson, The V. D., Company
382 Armstrong Machine Works
382 Armstrong Steam Trap Company
632 ASME Mechanical Catalog and Directory
686 Automatic Switch Company
420, 422 Babcock & Wilcox Company, Tubular Products Div.
515, 519 Bailey Meter Company
437 Barber-Colman Co. Wheelco Instruments Div.
641 Barnes & Jones, Inc.
409 Beemer Engineering Company
563 Bergen Pipesupport Corporation
664 Biach Industries, Inc.
456 Black, Sivalls & Bryson, Inc.
690, 692, 694, 696 Bragar Co., Inc., Norman
556 Brown Boveri Corporation
446 Bruning, Charles, Company
566 Burling Instrument Company
471, 473 Cambridge Instrument Company
695 Carpenter and Paterson, Inc.
619 Chemiquip Company
689 Circle Clamp Corp.
482 Clark Bros. Co., Div. of Dresser Operations, Inc.
541, 545 Cleaver-Brooks Company
640 Cobon Plastics Corporation
625 Cobra Metal Hose Division D K Mfg. Co.
426, 428 Cochrane Corporation
690, 692, 694, 696 Conax Corporation
439 Consolidated Diesel Electric Corp.
645 Continental Electric Equipment Co.
640 Couse & Bolten Co.
615, 617 Crawford Fitting Company
620 Croll-Reynolds Eng'g Co., Inc.
470 Dampney Company
622 Davey Compressor Co.
565 Dekoron Products Div. Samuel Moore & Co.
438, 440 De Laval Steam Turbine Company
365, 369 Earle Gear & Machine Co., Helitork Div.
665 Eastern Power Equipment Corp.
643 Eddington Metal Specialty Company
690, 692, 694, 696 Electric Products Company

465	Electro Dynamic Div. of General Dynamics Corp.
678	Epic, Inc.
667, 669	Equipto Div. Aurora Equip. Company
659, 663	Falcon Alarm Company
481, 483	Fee & Mason Mfg. Co., Inc.
489	Flanders Filters Inc.
659, 663	Flow-Actuated Control Co.
431	Foster Engineering Company
406	Foxboro Company
475, 477	Garlock Packing Company
659, 663	Gems Co.
644, 646	General Controls Co.
465	General Dynamics Corp., Electro Dynamic Division
388	Golden-Anderson Valve Specialty Company
492	Graver Water Conditioning Co., Div. of Union Tank Car Company
592	Griffin Equipment Corporation
485	Grinnell Company, Inc.
381	Gulf Oil Corp.
414	Gulton Industries, Inc.
495	Hamon, Inc.
386	Harbison-Walker Refractories Company
578	Heating, Piping & Air Conditioning
365, 369	Helitork Div. of Earle Gear & Machine Co.
542, 546	Hobart Brothers Company
691, 693	Hoke Incorporated
416	Homestead Valve Mfg., Company
690, 692, 694, 696	Hope Electrical Products Co., Inc.
559	Hungerford & Terry, Inc.
640	Hydraulics, Inc.
518	I-T-E Circuit Breaker Company
361, 363	Illinois Water Treatment Co.
677	Industrial Press
509	International Nickel Company, Inc.
459	Janney Cylinder Company
659, 663	Jarco Services, Inc.
631	Jerguson Gage & Valve Co.
581	Johns-Manville Sales Corp
374, 376	Johnson Corporation
370	Kato Engineering Company
372	Katolight Corporation
578	Keeney Publishing Company
469	Kieley & Mueller, Inc.
572	Knapp Mills Inc.
362, 364	Lapp Insulator Co., Inc., Process Equipment Div.
676	Leibfried Mfg. Corp., C. H.
398	Lewin-Mathes Company Div. of Cerro De Pasco Corp.
510	Lubriplate Div. Fiske Brothers Refining Co.
560	McDonnell & Miller, Inc.
481	McGraw-Hill Publishing Company
659, 663	McIntosh Equipment Corp.
432	Magnetrol, Inc.
674	Malan Construction Corp
690, 692, 694, 696	Marcus Transformer Corp.
632	Mechanical Engineering
542, 546	Motor Generator Corporation
636	National Tube Div. U. S. Steel Corp.
688	Neptune Pump Manufacturing Co.
576	New England Gear Works
655	Niagara Blower Co.
410, 412	Nicholson & Co., W. H.
642	Norcross Companies, Sterling E., Kem-Feed Div.
722, 726	North American Aviation, Inc., Atomics International Div.
616	Nutype Valve Servicing Corp.
614	Onan & Sons Inc., D. W.
665	Optimum Control Corp.
415, 419	Owens-Corning Fiberglas Corporation
445	Penberthy Mfg. Co., Div. of Buffalo-Eclipse Corp.
659, 663	Pick Manufacturing Co.
464	Pittsburgh Corning Corp.
578, 582	Plant Engineering
623	Porter & Co., Inc., H. W.
481	Power
666	Power Chemical Co.
578, 582	Power Engineering
423, 425	Power Industry
442-444	Purolator Products Inc.
423, 425	Putman Publishing Co.
621	Rapid Electric Co.
673, 675	Raymond Corp., The
436	Republic Steel Corp., Steel and Tubes Div.
460	Ric-wil Inc.
685	Sarco Co., Inc.
690, 692, 694, 696	Scam Instrument Corp., The
596	Shell Oil Co.
476	Smith Corp. A. O.
493	Southern Power & Industry
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491	Strong, Carlisle & Hammond
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681	Sumco Engineering Co.
586, 590, 635, 637	Superior Combustion Industries, Inc.
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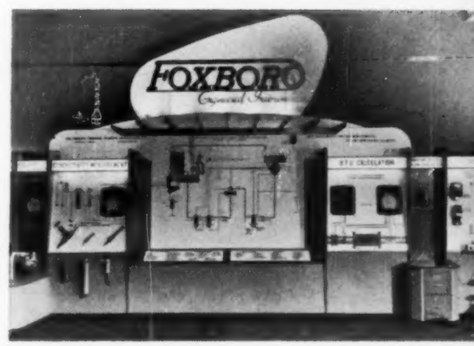
368	Texas Co., The
466	Thomas Flexible Coupling Co.
356	Titusville Iron Works Div. Struthers-Wells Corp.
609	Trerice Co., H. O.
672	Trinity Equipment Corp.
594	Troy Engine & Machine Co.
564	Union Steel Corp.
636	United States Steel Corp.
626	Valcor Engineering Corp.
687	Viking Pump Co.
613	Voss, J. H. H. Co., Inc.
659, 663	Walker, Crosweller and Co., Ltd.
573	Wallace & Tiernan Inc.
659, 663	Warrick Co., Charles F.
690, 692, 694, 696	West Instrument Corp.
437	Wheelco Instruments Div. Barber-Colman Co.
574	Wiedeke Co., The Gustav
373, 375	Wilson, Inc., Thomas C.,
532	Yarnall-Waring Co.
359	York, Otto, H. Co., Inc.
359	York Separators, Inc.
595	Yuba Consolidated Industries, Inc.
568	Zenith Electric Co.
671	Ziegler, G. S. & Co.



NEW YORK POWER SHOW

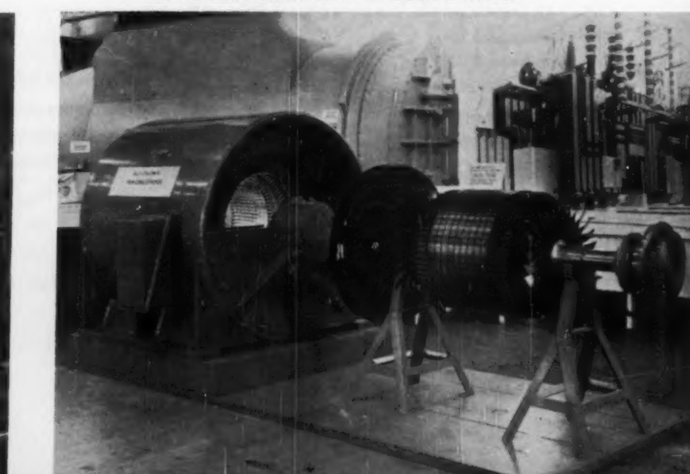
1929 Nash Engineering Company

Then . . . .

1922 First Exposition of Power and Mechanical Engineering

1938 Grand Central Palace

1948 Allis-Chalmers Fan Cooled Motor



and now

1958 ASME Power Show to Feature Improved Heat Control

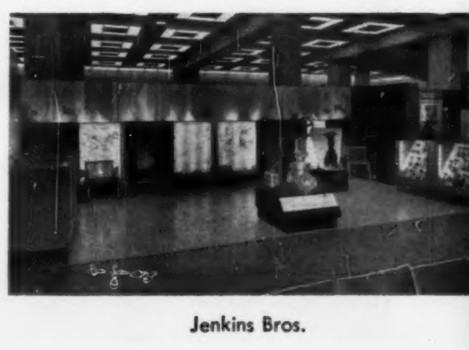
New Techniques in heat control will be featured among the many advanced designs at the 23rd National Exposition of Power and Mechanical Engineering.

Heat-exchange equipment has become one of the most fertile fields for invention in recent years. Even before the demands of atomic power had drawn attention to the apparent paradox of liquid metal cooling, changing concepts were beginning to influence designers. This year's exposition will feature their latest advances.

Also featured will be examples of functional machinery and processing equipment . . in addition to exhibits concerned with the generation and distribution of energy in heat, electricity, gases, compressed air and liquids, as well as motion. Admission, as usual, will be by invitation and registration only, exclusive of the general public.

Permutit Company,
Div. of Pfaudler Permutit Inc.

Bailey Meter Company



Jenkins Bros.

profile of the MECHANICAL CATALOG

MECHANICAL CATALOG

published by
THE AMERICAN SOCIETY OF MECHANICAL ENGI
29 WEST 39TH STREET, NEW YORK 18

June 10, 1958

When your company purchases the following types of products and services, do you have an influence in the purchase? Check below. (Influence = authorize, specify, decide, requisition, recommend, suggest or approve).

PLANT EQUIPMENT

	%
Valves	56.9
Pumps	55.7
Pipes and Fittings	52.1
Instrumentation and control	55.9
Turbines	
steam generating	13.3
steam, mechanical drive	14.0
gas, mechanical drive	7.6
Boilers	25.9
Stokers	14.0
Materials Handling Equipment	37.1
Packing, gaskets	37.3
Power Transmission	
gears	36.1
chains	30.8
belts	33.3
couplings	39.4
speed reducers	37.5
Electric Motors	
fractional horsepower	33.9
medium	39.7
large	25.7
Heat exchangers	39.3
Dust & Ash Precipitators	18.8
Fans and Blowers	45.1
Refractories	23.2
Lubricants	34.1
Water Treating Equipment	28.5
Tanks, steel plate	30.5
Engines (internal combustion)	17.9
Expansion Joints	29.6
Machine Tools	27.7
Compressors	39.3
Insulation	37.3
Air Conditioning	30.0
Welding and cutting Equipment	24.9

PRODUCT COMPONENTS

	%
Bearings	40.7
Power Transmission	
gears	30.6
chains	23.7
clutches	25.1
Instruments and controls	41.7
Metals	
ferrous	37.9
non-ferrous	36.7
Fasteners and springs	32.7
Electric Motors	
fractional horsepower	27.7
medium	23.4
large	15.0
Gaskets & O-Rings, seals	37.9
Hydraulic pumps and fittings	29.3
Tubing	33.1
Castings and forgings	31.2
Plastic parts	26.9

ENGINEERING TOOLS

Drafting Equipment	27.6
Computing and Analyzing Machines	13.6
Electro-mechanical Testing Equipment	25.9

MISCELLANEOUS

Nuclear components	7.3
Ultrasonic equipment	7.5
Aircraft parts	5.9
Rocket and Jet Propulsion Machinery	6.1

To receive the 1959 MC, please fill in the spaces below:

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Name (Please type or print - last name first)

....
Title Nature of Work

....
Company Name and Address

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Principal Product or Service

I need MECHANICAL CATALOG for selecting and specifying equipment, materials and supplies. Please send the 1959 edition to me at the address above.

SIGNED 15,458 mechanical engineers*

*total as of August 12, 1958.

Response to 1 500 questionnaires selected at random and tabulated by Barnard Inc., independent data compiling bureau of 432 Fourth Avenue, New York 16, N.Y

YOUR

New Catalogs

LATEST INDUSTRIAL LITERATURE

GUIDE

Those in industry who are responsible for various phases of plant, machinery, and product design, production, operating and application engineering will find much to interest them in this NEW CATALOGS Guide. Here, reputable manufacturers, most of whom have current advertising in MECHANICAL ENGINEERING and MECHANICAL CATALOG, offer to send you without obligation, their latest literature which is described on pages 187 to 222. For the Power Engineering Issue products and services have been divided into two broad categories. . . . . .those servicing the Power Industry and those reflecting other markets. The Catalog Index is a composite of both of these divisions.

FOR convenience in locating catalogs about particular equipment, product or service, a list is given below in which the numbers refer to the catalog items beginning on page 187. This will aid you in locating something specific although a perusal of the entire list may disclose other items of more than usual interest to you.

This November 1958 insertion of NEW CATALOGS Guide replaces the regular "Keep Informed" Section for this issue. The "Keep Informed" Section will appear regularly again beginning with the next issue.

Make a selection and indicate on the coupon, page 186, by circling the numbers of the literature described and fill in the balance of the coupon completely, for no literature will be sent if firm connection and position are not given. Mail to—

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Help yourself to this useful literature—you incur no obligation when you return this coupon.

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Catalog Index by Products

Continued on Page 186

Use Coupon on Page 186

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YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

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Please send me without cost or obligation the literature indicated by the following circled numbers which appear in "Your NEW CATALOGS Guide" in the November 1958 issue. (Requests limited to 25 catalogs)

POWER ENGINEERING:					1	2	3	4	5	6	7	8	9	10
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Name ....

Position ....

Company ....

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11-58

NOT GOOD AFTER DECEMBER 15, 1958

CATALOG ITEMS
Start on next page

YOUR

New Catalogs GUIDE — LATEST INDUSTRIAL LITERATURE

POWER ENGINEERING

1 CENTRIFUGAL PUMPS

Fairbanks-Morse—New Bulletin 5810-11 covers pumps for application in fire and booster service, water circulating, municipal water supply systems, pneumatic water systems, brine circulating, air washer circulating and other industrial uses. Capacities range from 50 gpm to 4500 gpm with beads to 300 ft.

2 BOILERS, ACCESSORIES

Bituminous Coal Institute—Revised, expanded edition of Guide Specifications (GS-1) covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants (750–6000 lb per hr). Included are layouts of efficient, economical equipment, specification criteria on coal and ash handling; boilers, stokers, controls.

3 STEEL VALVES

Edward Valves, Inc.—Catalog 14 describes cast and forged steel valves for power, petroleum, chemical, marine, and industrial applications. Data includes ASA dimensions, ASA pressure-temperature ratings, and ASTM basic materials specifications, as well as curves and formulas for correlating valve size and pressure drop.

4 WATER TUBE BOILERS

Henry Vogt Machine Co.—A 24-page bulletin describes Class VF and Class VS 2-drum bent tube boilers. Photos and line drawings illustrate typical units as installed in industry.

5 TURBINE SEAL

Koppers Company, Inc., Metal Products Div.—A 4-page folder on Huhn carbon rings for steam turbine applications discusses labyrinth, carbon garter spring ring and carbon ring sealing devices.

6 VERTICAL TURBINE PUMPS

Layne & Bowler, Inc.—A comprehensive book explains vertical turbine pumps. Included in the 72-page hard-bound book are graphic tables, photographs, drawings and charts.

7 CYLINDERS

Ledeen Mfg. Co.—A 12-page bulletin illustrates and describes the company's line of cylinders for air, oil, water, gas or steam operation in medium, heavy and super-duty construction. Selection information, ratings and limitations, and rod and head attachments are included.

8 CENTER GUIDED CHECK VALVE

Miller Valve Co. Inc.—An eight-page bulletin illustrates and describes the Streamflow center guided check valve, said to be silent and shock-proof, and which can be installed vertically or horizontally. Specifications and dimensions are tabled.

9 MOYNO PUMPS

Robbins & Myers, Inc.—An eight-page brochure describing the history and added benefits derived from use of the Moyno pump. Phases detailed about this "progressing cavity" pump includes its principle of operation, performance, construction, capacities, and speeds.

YOUR

New Catalogs GUIDE

10 STEAM TURBINES

Terry Steam Turbine Co. Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions: a description of the Terry axial flow impulse, both single stage and multi-stage; Terry gears which are used for speed increasing and speed reducing.

11 TORQUE CONVERTERS

Twin Disc Clutch Co.—Bulletin 508 describes a new line of single-stage torque converters. Illustrations and diagrams to permit tentative selection of a torque converter for industrial engines ranging from 30 to 205 hp.

12 ALLOY STEELS

Bethlehem Steel Co.—Booklet 415-C, includes such subjects as "What is an Alloy Steel?" "Effects of Elements," "Grain Size," "Heat-Treatment," "Determining Depth Hardness." It contains nine tables of AISI and SAE specifications for open-hearth and electric furnace alloy steels–bars, billets, blooms, and slabs.

13 SPUN STEEL TUBING

American Cast Iron Pipe Co.—Illustrated 64-page catalog describes special products division facilities, the centrifugal spinning process, its advantages and illustrates versatility of application of tubes. It contains tables, technical data, engineering information for stainless and carbon steel tubes 2.25–50 in. OD.

14 DRILLING POWER

Alco Products, Inc.—Eight-page bulletin describes diesel-electric power package for oil well drilling. They are powered by Model 251-B diesel engines, and said to be the only completely self-contained units for drilling. No additional power source, either a-c or d-c, is required to operate any part of the rig.

15 HEAT EXCHANGERS

American-Standard, Ross Heat Exchanger Div.—Bulletin 1.1K6 describes expanded, redesigned line of standardized, pre-engineered Type BCF exchangers. New features include baffles with flanged lip at tube holes and outer edge for improved thermal characteristics; movable feet; corrosion-resistant copper alloy core assembly; and cast iron bonnets. Specifications detail 46 stocked sizes in one, two and four-pass designs.

16 STEAM GENERATORS

Ames Iron Wks., Inc.—Bulletin GB-1 describes how generators have helped solve boiler room problems. The advantages of compact, simple and efficient design of complete packaged boilers are shown being put to use in plants across the nation.

17 POWER TRANSMISSION PRODUCTS

Boston Gear Works—A 576-page, pocket-sized catalog contains information on 7,124 standardized power transmission products. More than 50 pages of engineering data are included.

18 AUTOMATIC VALVES

A. W. Cash Valve Mfg. Corp.—An 82-page catalog describes and illustrates line of pressure reducing and regulating valves, relief valves, back pressure valves, hot water boiler control valves, anti-siphon vacuum valves, and strainers. Contains seven new items not previously included in former catalogs.

19 DEAERATION

Cochrane Corp.—Publication No. 4650 explains in capsule form the fundamentals of deaeration and why it is necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed.

20 PACKAGE BOILERS

Combustion Engineering, Inc.—Catalog P-439 describes new Type VP package boiler, shop assembled to provide steam capacities from 4000 to 50,000 lb per hour. Space requirements and specifications are in table form.

YOUR *New Catalogs* GUIDE

21 VIBRATING GRATE STOKER

American Engineering Co.—Literature describes a water cooled vibrating grate stoker in sizes from 25,000 to 150,000 lb of steam per hour. The unit does not require a dust collector and is said to burn low grade coals with efficiency or can be adapted for burning gas or oil in combination with coal or singly.

22 CENTRIFUGAL PUMPS

Worthington Corp.—Bulletin 2131-Bl illustrates and describes 2- and 4-stage centrifugal pumps for boiler feed and general medium pressure services in pressures to 750 psi and capacities to 2500 gpm. Cross-section and dimensional diagrams of the units are included, along with information on writing specifications.

23 EXPANSION COMPENSATORS

Flexonics Corp.—Bulletin AIA No. 30C-22 illustrates and describes expansion compensators for steam and hot water lines. Included is data on a high pressure type of 175 psi and a low pressure type to 60 psi.

24 GAS TURBINE ENGINES

Solar Aircraft Co.—New 24-page brochure describes the company's 500 hp Jupiter gas turbine engines. The brochure contains photos of installations, cutaway views of different engine configurations, performance charts, outline drawings. Sections describe comparative performance of gas turbine and diesel engines, principles of gas turbine power, components and accessories, and potential applications.

25 PROCESS CONTROL

Swartwout Co.—Bulletin describes electronic control and instrumentation for processing, power generation (including atomic energy), testing, research, and development. Principles of electronic transmission and control are discussed together with benefits, i.e., zero transmission lag, zero hysteresis and infinite resolution by continuous (stepless) modulation.

26 SQUARE HEAD CYLINDERS

Anker-Holth Div., Wellman Engrg. Co.—A 30-page data bulletin gives engineering specifications, ordering information for recently-introduced square head hydraulic cylinder line. Of tie-rod construction, line is rated for 2000 psi working pressures, up to 3000 psi in nonshock service. All mountings are available, standard bores range from 1½ through 12 in. Standardized mountings are said to provide complete interchangeability with most makes of square head cylinders.

27 AIR DIRECTIONAL VALVES

Westinghouse Air Brake Co., Industrial Products Div.—An eight-page catalog describes two-, three-, and four-way spool type directional valves with solenoid, lever, push button, pilot cylinder, cam, treadle, and pedal operators. Valves have tapped exhaust or open exhaust. In neutral, spools close all passages, connect delivery passages to exhaust or connect delivery passages to supply.

28 PRESSURE VESSELS

Koven Fabricators, Inc., Div. of L. O. Koven & Brother, Inc.—Bulletin No. 550 illustrates and describes mixers, kettles, vacuum and pressure vessels, autoclaves, evaporators, impregnators, condensers, stills, extractors, tanks, standpipes, piping, stacks.

29 WELL WATER SYSTEMS

Layne & Bowler, Inc.—Bulletin 100 contains case histories and application photos of well water systems, pumps, shutter screens, special drilling applications featuring vertical turbine pumps.

A world of facts at your finger tips. Use coupon on page 186 for free catalogs you need.

YOUR *New Catalogs* GUIDE

30 HIGH TEMPERATURE WATER PUMPS

Dean Brothers Pumps Inc.—Circular 214 describes the firm's line of standard centrifugal pumps for high temperature water systems used for large volume space heating and for industrial process heating. Pumps for boiler and system circulating and for boiler water make-up are illustrated. Pump data and stuffing box sealing information are also included.

31 LUBRICATED PLUG VALVES

Homestead Valve Mfg. Co.—A 28-page catalog shows 100 per cent pipe area, venturi, round port, and diamond port lubricated plug valves in a variety of metals for 150-lb steam working pressure, 200-lb oil-water-gas, and ASA 150 and 300-lb classes. Complete with engineering dimensions, the catalog, Section 1 of Reference Book 39, also shows different types of power operators for valves, in addition to lever operated, and worm and gear operated valves.

32 INDUSTRIAL EQUIPMENT

Allis-Chalmers Mfg. Co.—Booklet 25B6057A makes reference from A to Z to literature available on the wide variety of products produced by the company. Capital goods equipment for almost every industry, in addition to construction and agricultural equipment, is covered, ranging from absorption machinery to zeolite softeners.

33 TORQUE CONVERTERS

National Supply Co.—Bulletin No. 468 describes single-stage torque converters for heavy industrial service, discussing background, design, types, sizes, circuits and applications. It also contains a capacity chart of the six sizes and 17 input ratings. Data sheets give application and dimension data of each of the six sizes, with performance curves, capacity chart, important features and typical torque converter arrangements.

34 HEAT AND POWER REFRACTORIES

Norton Co.—Thirty-two page brochure compiled for the benefit of boiler operators, setters, and engineers—to aid them in solving refractory problems and to help them obtain greater efficiency from their boilers. Also included is a temperature conversion chart, "Crystolon" brick specification tables and a quick-figuring efficiency chart for boilers.

35 FRACTIONAL HP MOTORS

Robbins & Myers, Inc.—A ten-page booklet describes its new line of Model R re-rated fractional horsepower motor available in ratings from 1/8 to 1 hp in polyphase, capacitor single phase, permanent split capacitor and (in the smaller ranges) split phase types. Totally-enclosed designs are included.

36 VALVE OPERATORS

Ledeen Mfg. Co.—Bulletins illustrate and describe company's line of pneumatically or hydraulically operated valve operators for direct or remote control of gate, diaphragm and plug valves. Selection information, torque ratings, dimensions, and weights are given.

37 HYDRAULIC TURBINES

James Leffel & Co.—Details on turbines that drive power generation and pumping units at the Bureau of Reclamation, Chandler power and pumping plant, are given in a 12-page bulletin, No. 1098-E. Descriptive literature on other recent turbine installations is also offered.

38 GEARMOTORS

Western Gear Corp.—Catalog 5806 gives information and integral and all-motor types of straight-line gear-motors. Standard units are available to 50 hp, double and triple reduction.

39 ELECTRONIC DATA PROCESSING

ElectroData Div., Burroughs Corp.—Eight-page Brochure No. 5220, describes latest electronic computing system designed for engineering, scientific and commercial applications. Details are given on speeds, programming, expandability, and filing capacities. Magnetic tape, paper tape, and punched card facilities available with this medium-price digital system are summarized.

YOUR

New Catalogs GUIDE

40 SCREW PUMPS

Warren Pumps, Inc.—Technical Bulletin 252 features Type CB high pressure screw pumps for various oil services requiring up to 1000 psi pressure. The viscosity range of the pump is 35 to 75,000 ssu. Selection nomographs, outline dimensions, sectional view, and details of design and construction are provided.

41 VALVE COMPARISON CHART

Ohio Injector Co.—Form 194R2 covers latest editions of new valve designs in the entire valve industry. Also listed is a valve trim comparison table.

42 ALL-METAL FLEXIBLE HOSE

Universal Metal Hose Co.—Catalog ID-100B, describes all-metal flexible hose and tubing products. The material is edited for the selection of the proper all-metal flexible hose product for a specific application.

43 PLASTIC PIPE FITTINGS

Grinnell Co.—A 16-page catalog on corrosion resistant pipe fittings, flanges, valves and pipe in normal impact grade and high impact grade, rigid, unplasticized polyvinyl chloride shows characteristics, advantages and limitations. Listed are operating pressures, temperatures, applications, price comparisons, fabrication advice, installation and supporting recommendations, dimensions and weights.

44 PROCESSING EQUIPMENT

Permutit Co.—A bulletin gives data on aerators degasifiers, deaerators, chemical feeders, precipitation equipment, filters, ion exchange equipment, gas analysis and control systems, valves, meters, flow controllers. Application photos show the equipment in various industries.

45 TUBE, BAR STOCK

Shenango Furnace Co.—Bulletin 156 gives information on standard bar and tube stock offered in GC Meehanite metal, GA Meehanite metal and Type 1 Ni-resist. A comprehensive physical properties chart is included.

46 GLASS PROTECTED STACKS

A. O. Smith Corp., Process Equipment Div.—Bulletin SS-202A illustrates and describes Permaglas smokestacks which feature glass fused to steel on both the inner and outer walls of the stack. Data is given on installation, cost comparison, the firm's manufacturing facilities.

47 CENTRIFUGAL PUMPS

American-Marsh Pumps, Inc.—Six-page Bulletin 350 describes horizontal split case, single stage, double suction centrifugal pumps. Types HLM and HIM for wide range of capacity and head conditions. Large sectional view explains 18 important features. Specifications, performance data and dimension tables are included.

48 AUTOMATIC MECHANICAL CLUTCHES

Mercury Clutch Div., Automatic Steel Products, Inc.—An eight-page folder gives specifications, applications and special data on the two general types of clutches for gasoline engines and electric motors. Also listed are representatives who are qualified to assist in the proper selection and application of the firm's clutches.

49 STEAM TRAPS

Armstrong Machine Wks.—An enlarged 48-page manual and steam trap catalog includes open float and thermostatic traps, pipe strainers to 6 in. in steel and semi steel, useful steam pipe sizing tables. Fundamentals of good trapping, trap selection, installation, testing, trouble-shooting, and repair are discussed.

50 METAL HOSE

Atlantic Metal Hose Co.—Bulletin 500-A contains descriptions and illustrations of high pressure hose made of heavy bronze or galvanized steel strip, air jacketed hose for diesel exhaust, conveyor hose for ventilating and exhausting. Bulletin 21-A covers flexible stainless steel hose.

YOUR *New Catalogs* GUIDE

51 AIR, HYDRAULIC CYLINDERS

Anker-Holth Div., Wellman Engineering Co.—Brochure AD-3 describes and illustrates standard air and hydraulic cylinders and valves, including five types of air cylinders, four types of hydraulic cylinders, also rotating air and hydraulic cylinders.

52 MARINE LOADING ARM

Chiksan Co.—Bulletin illustrates in detail features of a marine loading arm, operated by hydraulic controls. Arms of the unit swivel out from rest of hookup position in one and a half minutes. It operates with fluids from −60 to 225 F, and is currently available with arms of 6, 8, 10, 12, and 16-in. diameters.

53 VIBRATING CONVEYORS

Carrier Conveyor Corp.—"Natural-Frequency" vibrating conveyor Bulletin No. 112, 12 pages, describes new application of scientific natural-frequency vibrating principle as applied to Carrier vibrating conveyors with great reduction in power requirements, double capacity, and significant savings in maintenance and down-time costs. Illustrates applications for detergent powder, crushed stone, foundry sand, castings and shake-out, spiral elevating for air cooling and other drying, heating, separating and blending processes; other uses and engineering data.

54 STEAM TRAPS, FLUID SPECIALTIES

V. D. Anderson Co.—A 36-page catalog contains engineering information on sizing steam traps, strainers, air release valves, and line type purifiers. Specifications, capacities sizes, pressures, weights on inverted bucket, thermostatic, float, combination and high pressure steam traps and other fluid specialties are given. Piping layouts are included.

55 INSTRUMENTS, CONTROLS

Leeds & Northrup—Booklet ENT lists the company's publications on instruments for research, teaching, and testing; instruments and controls for industrial plants and power plants; and heat-treating furnaces.

56 SPREADER STOKERS

Hoffman Combustion Engineering Co.—Catalog No. 55-CAD describes and illustrates features of moving-grate spreader stokers. Catalog 55-PDG describes, illustrates, and supplies additional information on spreader stokers with dumping grates. Capacities from 20,000 to 500,000 lb of steam per hour.

57 COOLING TOWERS

Marley Co. Bulletin DFA-58 details intermediate capacity cooling towers. Included are specifications of double-flow Aquatowers in Series 8, 12, and 14 models (both wood and steel structures). Dimensional drawings of towers and schematics of attachment of tower to grillage are included.

58 HEAVY DUTY V-BELT

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin M210 describes a new Condor LS V-belt made for long center, heavy duty drives. The belt features a precision proportioned construction to eliminate V-belt whip and turn-over.

59 AERATORS FOR BULK STORAGE

Bin-Dicator Co.—Catalog describes and illustrates Bin-Flo, nonclogging air pads which use small volume low pressure air to restore flow characteristics to ground materials in storage. Dimensional drawings, mounting details, typical applications, wiring diagrams, list of users are included.

60 POWER PLANT PUMPS

Byron Jackson Pumps, Inc.—A bulletin covers the firm's line of standard pumps for all power plant requirements, from a 12,000 hp, double-case boiler feed pump, to condensate, circulating and booster pumping duty. Special pumps for nuclear power plant installations are covered.

YOUR

New Catalogs GUIDE

61 DATA PROCESSING

Consolidated Electrodynamics Corp.—Technical bulletins describe MicroSADIC analog-to-digital conversion equipment, recording oscillographs, amplifying systems, and direct-writing oscillographs. Operating information and description of applications are also included. Bulletin Nos. 3004, 1585A, 1536B, 1500D, 1598B, 1522D, and 1589 are offered.

62 DIESEL ENGINES

Alco Products, Inc.—Bulletin DE-6 presents specifications, fabrication features of Model 251 diesel engines. Bulletin contains foldout with cross-section and captioned illustrations of major components of 6-cylinder in-line engine and 12 and 16-cylinder Vee-type engines.

63 STEAM GENERATOR

Erie City Iron Works—Catalog SB-59 describes the firm's Keystone steam generator which has been designed as a baffleless, pressurized two-drum water tube packaged unit. The unit is said to be completely integrated and requires no field piping, wiring, brickwork, or special foundation.

64 BOILER SERVICE VALVES

Everlasting Valve Co.—Bulletin describes the Everlasting Quick-Opening and Slow-Opening Straightway Valves, Angle Valves, Y-Valves, and Duplex Blow-Off Units, with specifications, materials of construction, and dimensions of each type. Illustrations include details of design, sectional and exploded views, and explanations of operation of the valves. A section of the bulletin also describes Everlasting Valves for fire protection.

65 HYDRAULIC MACHINERY

Watson-Stillman Press Div., Farrel-Birmingham Co.—A 24-page bulletin gives information on injection, compression, and transfer molding machines for the plastics industry; extrusion presses for ferrous and nonferrous metals; metalworking equipment; railroad shop equipment; ordnance equipment; standard and special machinery for general industrial applications.

66 FIRE PUMPS, FITTINGS

Peerless Pump Div., Food Machinery & Chemical Corp.—A 32-page bulletin, No. B-1500, describes, illustrates, and tabulates, with dimensional data, hundreds of models of Underwriters approved horizontal and vertical centrifugal fire pumps, fittings, and drivers for application to commercial and industrial risks. Addendum includes selection charts with data for each model.

67 RECORDING SYSTEMS

Consolidated Electrodynamics Corp.—Technical bulletins covering DataTape magnetic-tape recording and playback systems furnish descriptions and specifications for airborne and ground-based components and accessories. Ground system is described in Bulletin Nos. 1576, 1608, 1613, and 1615. Airborne components are covered in Bulletin Nos. 1592-5, 1578, and 1607.

68 STEEL PRODUCTS

Aristoloy Steel Div., Copperweld Steel Co.—A 48-page catalog presents electric furnace steel production, melting, rolling, finishing, thermal treating, and conditioning. It includes listing of blooms, billets, slabs, and bars, available in standard and special analysis, including those that can be leaded. Rolling limits and chemical analysis are also shown.

69 STEAM GENERATORS

Foster Wheeler Corp.—Bulletin B-56-5 gives drawings and technical data on steam generators in 60 installations. Also included is data on accessory equipment, reheaters, and superheaters.

70 VIBRATION TESTING SYSTEMS

Ling Electronics, Inc.—A four-page bulletin describes the firm's line of electronic vibration testing systems for random, complex, and sine wave testing. Electronically-driven power generators rated from 7000 to 90,000 va and with random output up to 42,000-lb force peak are covered.

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

71 OIL AND GAS BURNERS
Engineer Co.—Bulletin OB-63 illustrates different types and sizes of gas and oil burners and includes engineering data and specifications for pumping and heating sets for all types of liquid fuels.

72 ROLLER CHAINS, SPROCKETS
Diamond Chain Co., Inc.—Catalog 757 covers the firm's line of stock roller chains and sprockets. Data on selection, establishing service horsepower and determining size of driven sprocket is included.

73 ROTOSTOKERS
Detroit Stoker Co.—RotoStoker Type CC (continuous cleaning)—Catalog No. 800 describes this overthrow spreader stoker with continuous cleaning grates for boiler capacities of 5000 to 75,000 lb of steam per hr. Burns bituminous and lignite coals and refuse fuels—smokeless operation.

74 VALVES
Ledeen Mfg. Co.—A 16-page bulletin illustrates and describes the company's line of hand, foot, power and solenoid operated valves, air, oil, gas or water powered. Bulletin gives operating and flow cycles, dimensions and weights.

75 FOUR-CYCLE V-ENGINES
Nordberg Mfg. Co.—Four-cycle V-type engines are described in an 18-page bulletin. Examples are shown of the significant advancements in diesel engine performance for V-type engines that are supercharged, supercharged and intercooled, and Supairthermal.

76 THERMOCOUPLES
Aero Research Instrument Co.—An enlarged data catalog describes AerOpak thermocouples for users in the nuclear, aircraft, industrial, and process fields. Temperature ranges from 400 to 2000 F; diameters are .025 to .313 in. The units can be bent to shapes and weldments can be performed directly on the thermocouples which are pressure tight to 50,000 psig.

77 STEAM GENERATOR
Mears-Kane-Ofeldt, Inc. Div., S. T. Johnson Co.—Bulletin 8-C covers new horizontal steam generator available in 6½, 15, 25, and 33 hp sizes for use with gas, oil, or combination gas or oil.

78 PIPING INSULATION MANUAL
American Gilsonite Co.—A 20-page booklet covers the methods of application of Gilsulate, a new insulation for hot underground pipes. It describes the three grades, how to determine ditch size for various pipes and types of soil, and gives sample problems.

79 HOT-DIP GALVANIZING
American Hot-Dip Galvanizers Assn.—A 16-page booklet outlines rust prevention in industrial and consumer products through the use of the hot-dip galvanizing process. Included are photographs of products made by the method, and illustrations of production and quality control. Chart compares method with other types of rust prevention.

80 BLOWERS, EXHAUSTERS
Miehle-Dexter Div.—Six-page folder on 3-lobe rotary positive industrial blowers and exhausters covers advantages over conventional 2-lobe blowers in pressure range, size, weight, cost, and service. Operating data, capacity curves, and typical applications, including use in pneumatic conveying, are given for 24 production models.

81 OIL AND GAS BURNERS
Ray Oil Burner Co.—A new illustrated 16-page catalog gives specifications and capacities of commercial and industrial gas, oil, and combination gas-oil burners. It covers fully automatic, semi-automatic, and manually controlled horizontal rotary oil burners, gas burners, and combination gas-oil burners: commercial and domestic pressure-atomizing types for oil, gas, or combination gas-oil inshot gas burners; forced draft packaged burners. Tables and other technical data are included to aid in selection.

82 BOILER SAFETY DEVICES
Reliance Gauge Column Co.—Bulletin 516 is a condensed catalog of water columns, water-level gages and accessories, and liquid-level alarms. It is a key to more complete catalog sections describing this class of equipment is made by Reliance.

83 FINNED-TUBE HEAT EXCHANGERS
Alco Products, Inc.—Bulletin describes longitudinally finned tube heat exchangers said to offer unequalled heat-transfer characteristics provided by metal-to-metal fusing between U-shaped fin channels and tube. Publication includes mechanical specifications and charts showing finside coefficient and finside pressure drop.

84 TEMPERATURE, PRESSURE CONTROLS
Power Regulator Co.—A 12-page booklet illustrates and describes nine basic types of temperature and pressure controls. Included are self-operating regulators, water mixing equipment, pneumatic control instruments, indicating and recording instruments and control valves.

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

85 EXPANSION JOINTS, PIPING DESIGN

Marquette Coppersmithing Co.—Semi-technical, short report covers service history, test results, manufacturing procedures related to Omega expansion joints and their application to power and process piping systems.

86 BOILERS, STOKERS

James Leffel & Co.—Information on Scotch boilers for gas, oil and coal firing and automatic under-feed stokers is given in a 28-page bulletin, No. 236. The brochure includes test results, performance data, and details of design and construction.

87 AUTOMATIC CONTROLS

Mercoid Corp.—Catalog Number 858, a 60-page reference book for engineers, contains information on automatic controls for pressure, temperature, liquid level, and mechanical movement. Transformer-relays and mercury switches are also listed.

88 VENTURI TUBES

Builders-Providence, Inc., Div. B-I-F- Industries, Inc.—Design features, comprehensive dimensional data, capacity tables, recovery tables on venturi tubes are included in Bulletin 110-N1A.

89 PURIFIERS, MIST EXTRACTORS SCRUBBERS, SEPARATORS

V. D. Anderson Co.—Bulletin No. 801 itemizes principal applications of purifiers which remove liquid, solid and dust entrainment from gases and vapors. Contains buying information on internal, receiver and line type separators, mist extractors, and scrubbers. Also describes Anderson's new Quick-Flex thermostatic steam traps as well as Super-Silvertop and Heat-Kwik steam traps and Anderson strainer and float traps.

90 HOT PROCESS SOFTENERS

Cochrane Corp.—Bulletin 4800 illustrates and describes hot process softeners for boiler plant water conditioning. Data is given on water treatment and the principles of operation of the firm's equipment are diagrammed.

91 CHIMNEY DESIGN, MAINTENANCE

Consolidated Chimney Co.—Booklet illustrates and describes design, building, maintenance, and repair of chimneys. Included is design data, how to determine chimney size, standard specifications for radial brick and reinforced concrete chimneys, information on special acid proof and high temperature linings, and installation of aviation obstruction lights and lightning rods.

92 SOLENOID VALVES

Ruggles-Klingemann Mfg. Co.—Revised Catalog E on electrically operated valves includes standard solenoid valves with improved features. Solenoid trip valves are not available with explosion proof solenoid enclosures. New additions are free handle solenoid trip valves, motor operated valve and epichron control switches.

93 ROTARY JOINTS

Seamlex Co.—Eight-page Bulletin 5500-B describes rotary joints for steam, water, and air. Information on mechanical construction, engineering features, operating results is included with diagrams illustrating three engineering principles responsible for triple protection against leakage.

94 STAINLESS STEEL

Sharon Steel Corp.—A 32-page catalog offers description, chemical composition, strength factors, physical properties and applications for stainless steels, including the 200, 300 and 400 series. Forging ingots and rolled-in surface patterned stainless steels are included.

95 STEAM SURFACE CONDENSERS

Maryland Shipbuilding & Drydock Co., Industrial Products Div.—A brochure describes products and experience of the company in the heat transfer and fabricated-machined component parts manufacturing capital equipment industry. Emphasis is on steam surface condensers.

96 BRUSHING TOOLS

Osborn Mfg. Co.—An eight-page booklet describes a new concept of brushing tools for power finishing. It shows designs and applications of a new revolutionary brush said to extend the basic principles of power brushing into entirely new fields of power brush usage.

97 PROCESS CONTROL RECORDS

Taylor Instrument Co.—A 20-page catalog illustrates new 90 J series Transcope recorders. The units record or indicate three process variables; have set point transmitter, automatic-to-manual and cascade switching levers; process output and cascade indicators, high-low electric or pneumatic alarms.

98 COUPLINGS

Snap-Tite, Inc.,—Four bulletins and various data sheets cover couplings for high pressure systems, gravity flow systems, vacuum systems and hydraulic systems. Cutaway photos, diagrams and flow charts are included in the literature.

YOUR New Catalogs GUIDE

99 SQUIRREL CAGE MOTORS

Sterling Electric Motors, Inc.—A 64-page catalog illustrates a-c squirrel cage motors, speed reducers, and variable speed drives. Featured additions are right angle gear motors, right angle variable speed drives, and an expanded range of variable speed drives from 4660 to 1.3 rpm in variations from 2:1 and 10:1.

100 CONTROL ADAPTERS

F. W. Stewart Corp.—A 16-page catalog describes various adapters for use in conjunction with flexible shafting. These adapters have proven to be most advantageous for control or transfer of action from the source of power to the control unit, the firm states. Adapters pertinent to aviation, automation, electronics, machinery, radio, and other fields are described.

101 FLUID POWER DRIVES

Oilgear Co.—A 32-page bulletin, No. 10600, explains advantages, operation, and characteristics of Any-Speed drives. Performance curves and block diagrams on different types of rotary applications are included.

102 PROCESS INDUSTRY TUBING

Babcock & Wilcox Co., Tubular Products Div.—A 16-page bulletin, TB-417, is in illustrated booklet presenting information on the application of tubing, pipe, and welding fittings in the process industry. Selection of materials analyses, physical and mechanical properties of various tubing steels are included.

103 STAINLESS PIPE WELDING

Arcos Corp.—How to make the first, or root pass, in welding stainless or alloy pipe, welding from one side only is the subject of an 11-page bulletin. The use of a specially designed consumable insert to produce a sound weld, crevice free, with a flat contour inside the pipe, is described.

104 STANDARD MOTORS

Sterling Electric Motors, Inc.—A 12-page colored brochure describes the firm's line of standard electric motors. The bulletin illustrates applications and contains selection information. Exclusive design advantages are described.

105 CONTROLLED-AIR-DEVICES

Bellows Co.—Bulletins BM-25 and ML-3 illustrate and explain air motors and the choice of built-in valves and auxiliary hydraulic controls available for them. Bulletin ML-3 also describes the basic types of complete-work-units, such as power feeds, work feed tables, drilling units. Both booklets contain application photographs.

106 REFINERY PUMPS

Dean Brothers Pumps Inc.—Circular 201 describes new line of heavy duty centrifugal pumps for refinery and process service with top suction and discharge nozzles. Built to API and major oil company specifications, the units have capacities up to 1000 gpm. Pump sizes, mechanical design specifications and sectional view with parts list are included.

Read carefully . . . select wisely, then send coupon on page 186 now for your free catalogs. Requests limited to 25 catalogs. (Sorry, no catalog distribution can be made by us to students.)

Watch out for the risks of

QUESTION MARK FITTINGS!

- *WASTED DOLLARS*
- *PRODUCTION SHUTDOWNS*
- *HAZARDS TO LIFE*
- *DAMAGE TO YOUR REPUTATION*

SUB-STANDARD THICKNESS

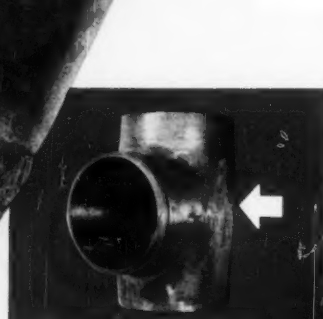
This Question Mark elbow cracked after welding. Minimum wall thickness was 24.9% less than nominal, compared to 12.5% permitted by ASA B16.9 code. Also, material was low in silicon.

NON-UNIFORMITY

Often, Question Mark fittings are out of round, or not uniform in center-to-face or face-to-face angle. Radius of this 180° return is not uniform.

SUB-STANDARD DUCTILITY

Question Mark 45° elbows of this assembly cracked clear through in four places after welding due to improper manufacture, resulting in ductility of about 50% of ASTM standards.



PATCHED DEFECTS

Imperfections such as the welded-in area of this Question Mark tee are often hidden by paint. They can be source of failure.

IMITATING TAGS

Some Question Mark fittings use welded-on identification tags like this—an oval shape to imitate the world-famous tag of TUBE-TURN products. It gives only size and schedule.

A message in the interests of top-quality piping . . . by
Tube Turns, Louisville, Kentucky

YOUR

New Catalogs GUIDE

107 RIGID PVC PIPE

B. F. Goodrich Industrial Products Co.—Bulletin 10051-A covers properties, chemical resistance, design data, specifications, and installation of Koroseal rigid vinyl piping.

108 PACKAGE WATER TUBE BOILER

E. Keeler Co.—A 10-page catalog on water tube package boilers contains illustrations and data on a unit available in capacity range of 6000 to 60,000 lb-steam per hour.

109 HEATING EQUIPMENT

Iron Fireman Mfg. Co.—A 60-page booklet covers engineering data on oil, gas and coal fired heating and power equipment. It is designed, not as a service manual, but to provide architects and engineers with information for better understanding the problems of fuel handling.

110 INDUSTRIAL COMPRESSOR

Joy Mfg. Co.—Bulletin describes Wn-224 heavy-duty, four-cylinder industrial compressor, the largest package-type compressor available. Detailed cross-section drawing and complete specification and dimension chart provide description of the unit which has a power range from 350 to 1250 hp and pressures from 85 to 125 psig.

111 CHEMICAL PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 137 illustrates and describes Type SVC pump, developed for efficient and economical transfer of hydrocarbons, chemical solutions, acids, and condensates in process installations. The water cooled, centrifugal pump has temperatures to 800 F, capacity from 15 to 3000 gpm at a working pressure of 600 psig, a differential head of 700 ft and speeds to 4000 rpm.

112 COMBUSTION ANALYZER

Bailey Meter Co.—Instantaneous analysis of exit gases from all types of boiler and industrial furnaces is said to be accomplished by portable Heat Prover combustion analyzer described in Product Specification E65-5. Illustrated in catalytic combustion principle by which per cent by volume of oxygen and combustibles present in a gas sample measured and indicated.

113 AUTOMATIC DATA SYSTEMS

Hagan Chemicals & Controls, Inc.—Bulletin MSP 154 describes Kybernetes automatic data handling systems. The electronic equipment logs, monitors, computes any number of input variables at better than 0.2 per cent overall full scale accuracy. Bulletin includes basic design parameters and technical description of various stages of the equipment.

114 HYDRAULIC HOSE FITTINGS

Parker Fittings & Hose Div., Parker-Hannifin Corp.—Catalog 4440 describes reusable Hoze-lok fittings and rubber covered wire braided hose for medium pressure service. Fittings are no-skive type, so cover of hose is not stripped off when assembling the fittings. Inside diameters range from 3/16 through 1 1/4 in.

115 CONSTANT TEMPERATURE PUMPS

Dean Brothers Pumps Inc.—Circular 195 describes new line of standard constant temperature pumps, Types CT-C and CT-R, for maintaining process temperatures when pumping of liquids which congeal, solidify or crystallize with loss of heat. Sectional views illustrate two methods of applying heat to pump: tracing and jacketing.

116 VALVE CONVERSION UNIT

C. H. Wheeler Mfg. Co.—A new automatic valve actuating conversion unit is described in Catalog V-200. It is called Valvmatic and converts hand-operated valves to motor operation without removing the valve from line or disturbing piping. It is actuated electrically, and will open and close windows and operate valves.

117 INDUSTRIAL POWER TOOLS

Rockwell Mfg. Co., Delta Power Tool Div.—Drill presses, grinders, shapers, planers, jointers, metal and wood cutting lathes, tilting arbor saws, unisaws, band saws, and radial saws are described in an 88-page catalog. Specifications, catalog listings, and descriptions of accessories for all tools are included.

YOUR

New Catalogs GUIDE — LATEST INDUSTRIAL LITERATURE

118 UNDERGROUND CONDUIT SYSTEMS

Stillwater Clay Products Co.—A four-page brochure describes vitrified clay conduit systems. This illustrated brochure describes the revolutionary new and exclusive Cert-A-Bar tunnel and Lock-A-Bar round systems and the many features of conduits, designed to assure permanent protection for piping. Information onc onduit design, installation, engineering, insulation, waterproofing specifications and fittings also is included.

119 VACUUM PUMPS

Leiman Bros., Inc.—A 16-page catalog, No. 757, describes rotary positive air and vacuum pumps, gas boosters and air motors. Included are 2 and 4 wing types; fan-cooled, water-cooled and new radiator air-cooled models; motor driven units; direct-coupled and belt-driven models, integral pump and motor; automatically controlled tank units; accessories.

120 LEADED STEELS

Copperweld Steel Co., Steel Div.—A booklet illustrates and describes the advantages of leaded steels and gives case histories of its use in a variety of products. Mechanical properties, machinability, and the chemistry of the products are listed in tabular form.

121 INSTRUMENTATION

Leeds & Northrup Co.—Four-page folder and three individual data sheets illustrate and describe features of pressurized, high speed sampling system with new sampling averaging unit, and magnetic O_2 analyzer and electronic recorder. The equipment determines oxygen content in boiler flue gas.

122 PROCESSING SERVICE PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 121-A describes SVS single stage, centrifugal pump developed for petroleum, petrochemical, chemical, and other processing services. Capacity ranges from 15 to 1300 gpm, discharge pressure to 600 psig, working pressure to 600 psig, differential head to 650 ft, temperature to 300 F, and speeds to 3600 rpm.

123 HIGH-STRENGTH STEELS

United States Steel Corp.—A 174-page manual discusses the essential principles of structural design and contains numerous formulas, charts and tables to assist in designing, for high-strength steels. The book covers engineering considerations and fundamental characteristics of high-strength steels, design considerations, working unit stresses, tension, compression, shear, stresses in beams, deformation and deflection.

124 DIAPHRAGM VALVES

Hills-McCanna Co.—A 12-page catalog, No. 104, describes diaphragm valves in terms of their advantages, applications and specifications. The three basic types of valve operations are shown and dimensional specifications are given. Information is also included on plastic bodies.

125 TORSIONAL VIBRATION DAMPER

Houdaille Industries, Inc., Buffalo Hydraulics Div.—A brochure describes the operation and use of viscous torsional vibration dampers. It includes a data sheet required to apply this damper to internal combustion engines and rotary systems likely to have critical speeds in the operating range. The damper is untuned and said to provide highly efficient damping even when damper is not optimum for the system.

126 VALVE-UNION

Worcester Valve Co., Inc.—Catalog WV 454 describes new Econ-O-Miser valve for positive leak-proof shutoff. It acts as both a valve and union. Comparative labor and materials costs for this valve and other types are given.

127 DIESEL, DUAL ENGINES

Nordberg Mfg. Co.—Series 29, two-cycle diesel and duafuel engines for stationary and marine service are described in a 16-page bulletin, No. 235A. With 29-in. bore and 40-in. stroke these engines are claimed to be the most powerful single action, two-cycle engines built in America.

128 EFFECTS OF CHECK VALVES IN OVERCOMING WATER HAMMER

Williams Gauge Co.—The cause, effect, and control of water hammer in piping systems are considered in an 8-page bulletin. After describing water hammer in nontechnical terms, the brochure indicates its potential damage to piping, instruments, and other parts of water systems, and considers methods of controlling it.

129 ROTARY PUMPS

Kraissl Co.—Bulletin A-1904 illustrates and describes Class 60 series direct motor drive rotary pumps in standard pressures up to 100 psig. General design specifications, features, capacity, speed pressure, and power consumption are covered.

130 SOLID, TUBULAR EXTRUSIONS

Babcock & Wilcox Co., Tubular Products Div.—Bulletin TB-413 tells of the division's tubular and solid extruded shapes, lists extrudable steels, high alloys and nonferrous metals and briefly explains the process, size ranges, dimensional tolerances and advantages of the use of extruded solid or tubular sections.

131 TWO-DRUM BOILERS

Erie City Iron Works—Catalog SB-58 covers VC two-drum boilers, said to provide high capacity in a compact design. The 12-page catalog describes improved features, design, construction, and application.

132 STREAMLINED BAFFLES

Engineer Co.—Bulletin BW-54 shows the design and describes the construction of streamlined baffles for many types of water tube boilers for various furnace designs and methods of firing.

133 AXIAL, MIXED FLOW PUMPS

C. H. Wheeler Mfg. Co., Economy Pump Div.—Horizontal and vertical axial and mixed flow pumps are described in a 12-page bulletin. Pumps are recommended for condenser circulation, primary water supply, drainage, irrigation, flood control and other applications which require large volumes of liquids containing small solids at low to medium heads.

134 AIR DIAPHRAGM CYLINDERS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes diaphragm air cylinders and diaphragm air chambers with effective areas from 9 to 50 sq in. and strokes from 1³/₄ to 4 in.

135 EXPANSION JOINT DESIGN GUIDE

Flexonics Corp.—A 28-page expansion joint design guide, Catalog 182, covers engineering application and selection data. A discussion of the various types of expansion joints on the market, types of pipeline motion solved by expansion joints, expansion joint design considerations, installation instructions, and selection data is included.

136 RADIAL ENGINES

Nordberg Mfg. Co.—A 16-page bulletin describes radial engines, two-cycle diesel, spark-ignition gas, and duafuel. The bulletin, No. 200A, describes recent engineering and design features which include supercharging of the spark ignition radial engines for an increase in rating of approximately 50 per cent over normally scavenged engines.

YOUR

New Catalogs GUIDE

137 HYDRAULIC PULSATION DAMPENER

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes a device that suppresses the pulsations and pressure surges which reciprocating pumps, centrifugal pumps and quick closing valves introduce into hydraulic systems.

138 VERTICAL PROCESS PUMPS

Goulds Pumps, Inc.—Bulletin 727.1 describes a new line of vertical process pumps built in all 316 stainless steel, stainless steel liquid end only, or all iron with stainless steel trim for wet or dry pit applications in depths to 20 ft. Units are available for capacities up to 720 gpm heads up to 190 ft. Single or duplex units are available.

139 HYDRAULIC CONTROL SYSTEMS

General Regulator Co.—Hydraulic controls, actuators, and power units for industrial processes, test facilities, power plants, and machine automation are illustrated and described in Bulletin GR-58-4.

140 STAINLESS AND HIGH ALLOY PIPE AND TUBING

Trent Tube Co., Subsidiary of Crucible Steel Co. of America—A 48-page manual detailing the complete operation of Trent Tube, manufacturers of Contour Trentweld, stainless steel and high alloy pipe and tubing. Included is information on Tubing Classifications—plus charts and tables applying to each class. Corrosion characteristics, weights, properties of alloys and conversion tables are also included.

141 HIGH TEMPERATURE PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 128 illustrates Types A, AC, OV, UNI, multistage, centrifugal pumps for high pressure, high temperature heavy duty services. The pumps range in size from 2 to 8 in. with maximum speeds to 6000 rpm, capacities to 2700 gpm, maximum temperatures to 850 F, discharge pressures to 2000 psig, and differential heads to 4500 ft.

142 MISSILE FABRICATION

Alco Products, Inc.—A 20-page bulletin outlines engineering and manufacturing qualifications of Alco as a missile fabricator. It lists the company's association with electronic developments, its basic research facilities, and the acceptance of its thermal engineering systems for applications, incl. the "Honest John" rocket and "Terrier" missile.

143 HEAVY DUTY COMPRESSORS

Pennsylvania Pump & Compressor Co.—Single stage, horizontal, water cooled, heavy duty air compressors in sizes from 10 to 125 hp and for pressures to 150 psig covered in Bulletin 201-E.

144 PLUG VALVES

DeZurik Corp.—A 36-page catalog covers eccentric plug valves. It explains eccentric action principle, and describes 1/2 through 20 in. valves and accessories, pneumatic, hydraulic and electric operators, pipe line strainers, and indicates service recommendations for valves. Valves are illustrated and dimensions are listed with flow charts.

145 WELD TUBE MILLS

Yoder Co.—A 64-page handbook describes the use of modern tube mills in the manufacture of pipe and tube. A description of the electric-weld process and photos, drawings and charts on the operation, capacities, and applications of various mills are included.

Fill in and mail the coupon on page 186 without delay.

YOUR *New Catalogs* GUIDE

LATEST INDUSTRIAL LITERATURE

146 PUMPS AND AIR COMPRESSORS

Worthington Corp.—A 24-page brochure detailing information on Standard industrial pumps and air compressors. Also included is hydraulic data and descriptive material on Worthington steam, rotary, power, centrifugal, regenerative turbine and circulating pumps. Also included is compressed air data and material on Worthington air compressors.

147 MAGNETIC DRIVES

Whitney Chain Co.—Data on design, drive features, operating and performance curves, output torque rating-dimensions, selection chart, as well as photographs of installations and applications of magnetic drives are included in the brochure. The new self-contained permanent magnet type magnetic drives are described as fitting new NEMA frame specifications and range in horsepower from 1 to 15.

148 CYLINDERS, CONTROLS

Westinghouse Air Brake Co., Industrial Products Div.—Three bulletins are offered. F9-180.00 covers basic pneumatic air controls; DO-OO-2 lists catalogs covering the division's line of products; D3-41.01 describes double acting, cushioned and non-cushioned streamlined cylinders.

149 SHORT-FLAME BURNER

Thermal Research & Engrg. Corp.—A four-page brochure describing thermal vortex type burners shows photographs of the flame characteristics with the burner operating on residual fuel oil and also operating with gas. The very short flame characteristic is described, particularly with regard to various types of heat equipment on which the burner might be used. Typical piping diagrams are also shown. A capacity chart for outputs up to 50 million Btu per hour is given.

150 AXIAL FLOW PUMPS

S. Morgan Smith Co.—Axial flow pumps of adjustable and fixed blade types are described in Bulletin 165. They are applicable for heads ranging from 5 to 55 ft and have been built in sizes from 11 to 150 in. in diameter with discharges from 3000 to 900,000 gpm. Bulletin includes typical settings, preliminary sizing data, specifications, and pump-turbine application.

151 COMPRESSOR VALVES

J. H. H. Voss Co.—Bulletin 53-G covers valves for air, gas or ammonia compressors. The valves are machined from solid stock; plates are machined and ground; valves and plates are of heat treated alloy or stainless steel and are Custom designed to fit the individual characteristics of the compressor for which they are manufactured.

152 NUCLEAR FORGINGS

U. S. Steel Corp.—Six-page folder describes and pictures such forgings as rings, disks, closure heads, and vessel flanges, available for use in nuclear reactor construction.

153 ALLOY STEEL PIPE

U. S. Pipe & Fdry. Co., Steel & Tubes Div.—Bulletin illustrates and describes turned and bored, metal mold, centrifugally cast alloy steel pipe. Case histories are given, along with a description of the manufacturing process.

154 TIMING BELT

United States Rubber Co., Mechanical Goods Div.—A set of manuals illustrate and describe, with drive tables, the PowerGrip timing belt. This drive is said to assure tooth-grip precision, and for power transmission its steel cable tension member provides horsepower that ranges from $^1/_{100}$ to 600 and up, without stretch.

155 BOILER, TANK CONTROL

Commercial Shearing & Stamping Co.—Three catalogs are offered. Catalog P-2 covers products for boiler and tank manufacture; P-3 standard shapes which are available without tool and die charges; G-1, applications and advantages of stampings, forgings and assembled products.

156 HEAT ENCLOSURES

M. H. Detrick Co.—A 50-page illustrated booklet "Heat Enclosure Methods," outlines the development of furnaces and furnace construction. Suspended arch and wall construction and their application are shown for various types of units. Engineering graphs and tables are presented. Special booklets on incinerators, forge furnaces, open hearths, and insulation available.

157 PROCESS EQUIPMENT

Pfaudler Co., Div. of Pfaudler Permutit Inc.—Bulletin 968 illustrates and describes glassed-steel, alloy reactors, columns, heat exchangers, condensers, evaporation equipment, storage, mixing and trailer tanks.

158 BOILERS, BURNERS

Kewanee Boiler Div., American-Standard—Loose-leaf binder with separate sheets for each series of boilers and boiler-burner package units available includes cutaway drawings, descriptions, specification data and dimensions, and sample specifications. Residential, firebox, and scotch-type boilers are covered, ranging to 651 hp.

159 PROPORTIONING PUMPS

Hills-McCanna Co.—A two-color, eight-page catalog, No. 604, covers details and specifications of the Model U and K mechanical and hydraulic drive metering and proportioning pumps, the Hills-McCannameter for precision pumping as low as 6 cc/min and the new Model 4411 chemical pump for systems requiring limited capacities.

160 PNEUMATIC TRANSMITTERS

Mason-Neilan—Bulletin No. 214 describes pneumatic transmitters for temperature and pressure applications in process control. Transmitters may be installed in any position without zero shift. Complete specifications and operational diagrams are included.

161 POLY-V DRIVE

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin 6638C illustrates and describes the firm's Poly-V drive, a power transmission system that uses only two cross sections instead of five standard V-belts. The unit is said to eliminate problems of matching belts because it is a single unit across the full width of sheave.

162 POWER TRANSMISSION

Ohio Gear Co.—A handbook on power transmission contains engineering charts, tables, and formulas on selection of gears and speed reducers. Dimensions of standard spur, bevel, spiral, helical, worm gears, and steel rack are tabulated.

KNOWLEDGE IS POWER

. . . and the free literature listed here may help you solve a perplexing power problem. Select catalog data carefully by number, then fill in coupon on page 186 and mail promptly. *Distribution by us to students is not included.* Requests limited to 25 catalogs.

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163 CENTRIFUGAL PUMPS

Pacific Pumps, Inc., Div. Dresser Industries, Inc.—"The Choice, Design, Characteristics and Maintenance of Centrifugal Pumps" is a reprint in booklet form of three published articles.

164 UPVC FITTINGS, FLANGES, VALVES

Tube Turns Plastics, Inc.—Unplasticized polyvinyl chloride pipe fittings, flanges and valves are the subject of a new booklet. It discusses industrial applications of PVC piping and gives complete specifications for threaded and socket type of fittings and flanges, in both normal and high impact grades.

165 BOILER-FEED PUMPS

Worthington Corp.—Bulletin 2131-B1 illustrates and describes Types UNB and UNQ two- and four-stage centrifugal boiler-feed pumps in capacities to 2500 gpm, heads to 900 ft. Cross sections of each type are shown, along with dimension diagrams.

166 SCRUBBER, PURIFIER

Centrifix Corp.—Bulletin 500 illustrates and describes the firm's WD scrubber for removing oil mist, acid fumes, dust and fly ash. Bulletin 600 covers the CD dry purifier for removing valuable materials entrained in any gas or air stream at any temperature without heat loss or the use of a wetting agent.

167 BRONZE GLOBE VALVES

Lunkenheimer Co.—A four-page, three-color detailed circular 602-2 on the two pressure classes of LQ600 bronze globe valves, for a variety of services from normal to exceptionally severe, is offered. The two pressure classes—rated at 150 lb SP, 300 lb WOG, and 200 lb SP, 550 F, 400 lb WOG—are described, and all features of each are listed. ASTM, ASME and military specification numbers of alloy for bodies and bonnets are included.

168 SHORT RETRACTING SOOT BLOWER

Diamond Power Specialty Corp.—Bulletin 1079A describes improved Model IR short retracting soot blower for cleaning water cooled boiler furnace walls, hopper slopes or narrow portions of tube banks adjacent to walls. Operates in extremely hot zones. Air motor, electric motor or manual operation. Automatic cycle.

169 HYDRAULIC POWER

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 201 illustrates and describes the firm's 2000 psi vane pumps designed for hydraulic power systems in mobile machinery. Operating characteristics of the units are shown in tabular form.

170 MARINE BOILERS

Titusville Iron Wks. Co.—Bulletin B-3333 illustrates and describes three-pass Scotch marine boilers for both power and heat. A table of certified test results, and data on mechanical and thermal features are included.

171 ROTARY POSITIVE GAS PUMPS

Roots Connersville Blower Div., Dresser Ind.—Bulletin XA-458 covers rotary positive displacement gas pumps 7-in. gear diameter and smaller. Selection tables, dimensions, performance data and illustrations for 18 standard sizes are included.

172 NUCLEAR ENGINEERING

Burns and Roe, Inc.—A four-page illustrated folder describes the construction firm's work in nuclear power generation and reactor facilities, environmental testing, aviation test facilities, materials manufacturing, processing, and handling.

173 WROUGHT IRON

A. M. Byers Co.—An eight-page booklet describes changes in composition that make the firm's 4-D wrought iron 25 per cent more corrosion resistant than former product. Illustrated in-service and laboratory test data compare it with other metals, comparative service life in numerous actual installations involving heat exchangers, smokestacks, brine lines, tanks, and high temperature services is discussed.

174 PVC PLASTIC VALVES

Lunkenheimer Co.—Circular 601 describes new all-molded polyvinyl chloride valves, which are light-weight and corrosion resistant. Molded in rigid form, the valve is said to be suitable for pressures up to 125 psi and temperatures to 150 F Large, cutaway illustration shows design detail. The circular lists industrial fluids these valves handle, features of valves, and dimensions.

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175 HEAT EXCHANGER TUBES

Aluminum Co. of America—Illustrated catalog contains relevant data on Alcoa aluminum heat exchanger tubes. Covers advantages, fabrication, application in petroleum and petrochemical industries, chemical, steam, atmospheric, air, and gas. Also use of aluminum alloys, fluid flow characteristics, heat transfer characteristics, resistance to corrosion specifications and data with tables. Form 10186.

176 LUBRICANTS, COMPOUNDS

Shell Oil Co.—A series of folders gives data on properties, testing, applications of a new atomic power lubricating grease, an extreme temperature range lubricant for missile applications, an emulsion-type lubricant for large low-speed diesel engines, compounds and fluids for open gears under extreme pressure loads, and the company's oil-print analysis for field diagnosis of motor oils.

177 FOUR-WAY VALVES

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 240B covers four-way valves designed for shockless hydraulic control on any directional equipment. A cutaway photo illustrates the pilot-operated, solenoid-controlled unit, and application data is given.

178 LONG TRAVEL RETRACTING SOOT BLOWER

Diamond Power Specialty Corp.—Bulletin 2111 describes new Series 300 IK long travel retracting soot blowers, for cleaning boiler tube banks in very hot locations. Positive drive by single, enclosed air or electric motor. Improved nozzle provides better cleaning with greater economy. Positive closed pitch helical blowing pattern assures full coverage of all surface.

179 ELECTRIC CLUTCHES

I-T-E Circuit Breaker—Catalog 6304-1A describes electro clutches, for engaging and disengaging machinery gears and drives. The 20-page catalog provides application information and specifications and dimensions on the firm's complete clutch line.

180 FORGED STEEL GATE VALVES

Lunkenheimer Co.—Circular No. 607 describes new forged steel gate valves for service applications 800 psi at 850 F, 2000 psi at 100 F. They are made in screwed and socket welding end design. A large cutaway illustration shows design detail.

181 STEAM GENERATORS

Titusville Iron Wks. Co.—Bulletin B-3255 illustrates and describes packaged steam generators from 10,000 to 60,000 lb steam per hour. A diagram of the unit and data on construction, performance, maintenance are included.

182 GAS TURBINES

Elliott Co.—Bulletin P-10 illustrates and describes a new line of power recovery gas turbines designed to expand waste process gases at temperatures up to 1250 F. The turbine-driven compressor delivers air to the process at pressures ranging from 30 to 200 psig.

183 POWER PLANT

Burns and Roe, Inc.—A six-page folder containing technical data describes design innovations of the Denskammer Point Steam Station (Roseton, N. Y.) The start of construction, start-up, operating efficiency, and plans for future expansion are covered.

184 FLANGE MOUNTED DRIVES

Falk Corp.—Flange mounted drives that bolt directly to the driven machine are described in Bulletin 7140. They are available for horizontal or vertical application, with high speed shaft up or down, in single reduction for $1/2$–10 hp, and in two double reduction ratios for $1/2$–5 hp.

185 FLOW CONTROL VALVE

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 143-A illustrates and describes the firm's multi-range flow control valve in $1/4$, $3/8$, and $3/4$ in. sizes. The unit is shown in a cutaway drawing and applications for machine tools, automation, and petroleum equipment are illustrated.

186 INDUSTRIAL LOCOMOTIVES

Rogers Bros. Corp.—A bulletin illustrates design and construction of heavy-duty [illegible] f diesel-hydraulic industrial locomotives, [illegible] track gages, 5 to 40 tons. Bulletin lists specifications of standard line, and describes special features and accessories available in custombuilt units.

187 GENERATORS, BOILERS

Wickes Boiler Co.—Bulletin 55-1 gives information on the facilities and products of the company including drawings of typical steam generators and shop-assembled water tube boilers. Units shown from 15,000 lb capacity of steam per hour to 300,000, designed to operate to 1000 psi. Duotherm vaporizers, economizers, superheaters, and airheaters are included.

188 STEAM PRESSURE REDUCING VALVE

Leslie Co.—Bulletin No. 582 gives facts on Leslie-Topper, a new concept in steam pressure reducing valve design. The unit has a mechanical piloting device that is entirely out of the path of steam and the bulletin offers comparison capacity regulation data and sizing information.

189 GAS TURBINES

Brown Boveri Corp.—A 20-page bulletin, 2619E, deals with a total of 1,000,000 kw of gas turbine capacity used for such applications as central stations, cement mills, steel plants, emergency power plants; units designed for burning natural or blast furnace gas and different grades of oil.

190 SPECIAL TRAILERS

Rogers Bros. Corp.—A catalog illustrates typical special trailers custom-built to carry loads from 5 to 250 tons, including transformers, reactors, engine-generator sets, shovels, and pre-stressed concrete beams. The trailer is designed to become integral part of finished products such as mobile power-units and mobile substations.

191 OIL/GAS BURNERS

Wickes Boiler Co.—Bulletin 58-1 provides information on oil/gas burners for shop-assembled and field erected boilers suitable for automatic combustion and safety controls. Single or multiple burner arrangements are shown. The burners are of steam, or air atomizing type for oil, center ring type for gas.

192 K LINE MOTORPUMPS

Ingersoll-Rand—Form 70022 covers the K line motorpumps available in 20 sizes for handling heads to 190 ft and volumes to 775 gpm. The units have precision made impellers, mechanical seals, threaded connections, varied discharge positions, easy mounting and drip-proof motors.

193 SURGE RELIEF VALVES

Golden-Anderson Valve Specialty Co.—An eight-page bulletin, W-2A, describes cushioned surge relief valves in sizes $1/2$ to 36 in. These valves are used to protect water lines against excessive pressures caused by surges in the system. Installation arrangements, parts lists, dimensions and specifications are included, along with technical information on installation and operation. Featured in a chart showing relief valve capacities.

194 CENTRIFUGAL PUMPS

Nagle Pumps, Inc.—A four-page folder, Selector, gives briefing on the company's line of pumps for abusive applications. Horizontal shaft and vertical shaft pumps are shown, the latter designed to reduce stuffing box and bearing troubles.

195 AIR CONDITIONING MOTOR PUMPS

Ingersoll-Rand—Form 7473 describes motor pumps of the KRVS-KRVSA line. They range from $1/2$ to $7\,1/2$ hp and are built for air conditioning, refrigeration, and coolant circulation work. The centrifugal units have cast bronze impellers which run directly off short motor-shaft extensions of NEMA frame motors. The eight-page booklet gives performance curves, along with data on dimensions and a work sheet for pump selection.

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OTHER PRODUCTS

251 SPHERICAL BEARINGS

The Heim Co.—Revised catalog gives engineering data on Unibal spherical bearings and rod ends. Dimensional information, load ratings are listed along with data on roller bearing and ball bearing flange units, center flange bearings, ball and roller bearing pillow blocks. A separate folder on the new Unibal ball bearing will be enclosed.

252 DRAFTING MACHINE

Universal Drafting Machine Corp.—Tracmaster, a drafting machine for large size work which features automatic board tilt, is described. The unit has beam-rails that require no initial alignment or subsequent adjustment for straightness. Engine-divided graduations on each rail divide, in effect, the drawing area into a 10-in. grid pattern.

253 PISTON, SEALING RINGS

Koppers Co. Metal Products Div.—A 24-page brochure illustrates and describes American Hammered piston and sealing rings for various types of industrial applications. Also available are four-page folders on conformable oil ring, marine piston rings, chrome-plated piston rings, piston rings for air and steam forging hammers, Teflon rings, railroad piston rings, and an eight-page brochure on metallic sealing rings.

254 IMPULSE STEAM TRAP

Yarnall-Waring Co.—Bulletin T-1744 describes a new impulse steam trap engineered especially for light condensate load applications. The trap is designed for use on steam tracer lines, steam main drips, small platens. It is available in $^1/_2$-in. size only, for operating pressures 8 to 600 psig.

255 FOOD FREEZING, CHILLING

Niagara Blower Co.—Bulletin 105 describes the firm's method used for food freezing, chilling, and warehouse refrigeration on a large scale without frost or ice formation.

256 CLUTCHES, BRAKES

Autotronics, Inc.—Catalog 957A illustrates and describes sub-miniature electro-magnetic clutches and brakes. Engineering and dimensional data, diagrams, and performance curves are given for ten models and combinations.

257 BELT CONVEYORS

Continental Gin Co.—A 86-page engineering data book, ID-581, shows belt conveyor products. It includes applicable data on the selection of components and belts for general belt conveyor service. A simplified selection table for pulley and shaft assemblies and mechanical equipment for use with belt conveyors is included.

258 GAGE LABORATORY INSTRUMENTS

Sheffield Corp.—A 20-page booklet illustrates and describes Accutron electronic dimensional inspection instruments. Applications, specifications on electronic height gages, internal and external measuring instruments, comparators are included.

259 VIBRATING SCREEN BEARINGS

SKF Industries, Inc.—Bulletin No. 466 announces and describes a new spherical roller bearing designed to absorb the heavy loads, high speeds, and eccentric motion of vibrating screens while meeting rigid lubrication requirements. Its cage is made of centrifugally cast bronze, having axially drilled and reamed pockets of a shape closely conforming to that of the rollers. Compared with the standard spherical bearing, it has 37 per cent more load carrying capacity, and normal fatigue life is extended 2.85 times.

260 FLEXIBLE, BALL, SWIVEL, SWING, AND ROTARY JOINTS

Barco Mfg. Co.—A group of catalogs cover joints for piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalies, and other fluids or gases. Complete range of sizes. Catalogs No. 215 "Flexible Ball Joints"; No. 265 "Rotary Swivel Joints"; No. 400 "Barco Swing Joints"; No. 310 "Revolving Joints" and No. 269 "High Pressure, Hydraulic Swivel Joints."

261 ELECTRIC HEATERS

Edwin L. Wiegand Co.—Catalog 975-B illustrates and describes electric blower-type portable unit heaters, wall and ceiling mounted unit heaters, forced air heaters for large areas, radiant and convection comfort heaters, thermostats and contactors for commercial and industrial use.

262 LEAD PENCILS

Eberhard Faber Pencil Co.—Four-color catalog sheet describes and illustrates new, improved Microtomic drawing pencils. It also features Race Kleen, Pink Pearl, and Rubkleen erasers, describing their uses by artists, draftsmen, and architects.

263 BALL BEARINGS

Split Ball Bearing Div., MPB, Inc.—A folder gives data on four new precision ball bearings for instruments, electromechanical devices and other precision mechanisms. The units are shown in actual size and specifications and dimensions are shown in tabular form.

264 REVERSING DRIVE

Funk Mfg. Co.—A catalog illustrates and describes the firm's Reverse-O-Matic drive said to be adaptable to any equipment that has forward or backward, or up and down motion, such as road rollers or fork lift trucks. One-lever controls speed and change of direction. Standard flanges adapt it to other power transmission components, including power take-offs, right-angle drives, transmission, and gear reduction.

265 ALUMINUM, MAGNESIUM CASTINGS

American Brake Shoe Co.—Brochure shows how precision, high-strength castings in light alloys can reduce weight, improve design, and cut costs in critical airborne components. Listed are mechanical properties guaranteed in castings of aluminum and magnesium alloys; government specifications for casting and inspection methods.

266 SHAFT SEALS

Syntron Co.—Two bulletins are offered on shaft seals. One gives data and specifications on mechanical shaft seals for rotating shafts on pumps, turbines, compressors, engines, and mixers. The other covers face-type marine shaft seals which feature a split, inflatable sealing ring that permits worn seal parts replacements without dry-docking large vessels.

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267 SPHERICAL ROLLER BEARINGS

Torrington Co.—A comprehensive catalog, No. 258, covers five standard series of self-aligning spherical roller bearings, with bore sizes ranging from 40 mm up through 1060 mm. Dimension tables, load ratings expressed as basic dynamic capacity, and line graphs showing modifying speed and life factors are included.

268 GEAR REDUCERS

Western Gear Corp.—Bulletin 5802 covers a line of SpeedMaster, parallel shaft type gear reducers. Engineering information is offered on single, double, and triple reduction reducers together with selection instructions. The reducers are offered in any reduction ratio desired with ratings up to 10,000 hp.

269 PLUG VALVE LUBRICANTS

Homestead Valve Mfg. Co.—A 16-page illustrated catalog gives lubricant recommendations for nearly 4000 service conditions for which lubricated plug valves can be used. This catalog, Section 1A of Reference Book 39, also shows lubricated plug valve accessories, fittings, automatic lubricators, lubricant guns, and gives information for choosing and ordering lubricants.

270 WELL SCREEN

Layne & Bowler, Inc.—Bulletin 900 covers improved Model 134 shutter screen for gravel wall wells. Specifications are included.

271 OPTICAL PARTS

Bausch & Lomb Optical Co.—A 16-page catalog of optical parts contains information on ground glass, heat absorbing glass, retardation plates, and the firm's precision glass engraving and optical coating services. A new price list detailing up-to-date individual part prices, discount procedures, minimum ordering quantities, and terms of sale is included. Catalog L-117.

272 CENTRALIZED LUBRICATION

Farval Corp.—An illustrated brochure, No. 26-S, offers 20 pages of material relating to centralized systems of lubrication. The booklet discusses principles of operation, product advantages and system components.

273 MULTI-STAGE COMPRESSORS

Norwalk Co.—Catalog 44 describes features of tandem, multi-stage compressors for air and commercial gases. Pressures up to 25,000 psig.

274 SELF-ALIGNING COUPLINGS

Koppers Co., Metal Products Div.—A 16-page brochure describes principles and features of Fast's self-aligning couplings. Illustrates and describes each available standard and special model. Also available are four-page folders on Model B, forged steel, cast steel, mill motor flex-rigid, and breaking-pin Jordan couplings.

275 OPTICAL TOOLING

Charles Bruning Co.—A 20-page illustrated booklet, explaining the theory, principles, and practice of the new technique of optical tooling. The booklet shows how optical tooling provides tolerances of .003 in. in 100 ft. It is claimed to offer easier construction, assembly, inspection, and unsurpassed dimensional control in erecting jigs, fixtures, and assembly structures.

Select desired Catalogs by number. Requests limited to 25 catalogs. Fill in coupon on page 186 and mail promptly.

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276 VARIABLE SPEED DRIVE

Cleveland Worm & Gear Co.—The firm's speed variator, a precision mechanical variable speed drive of 9:1 total range of ratio, is described in an eight-page, illustrated booklet designated K-200. The brochure provides product description and engineering information, including sectional views, dimensions, capacity ratings.

277 COPPER TUBE FITTINGS

Chase Brass & Copper Co.—Publication G-1 SF 57 covers solder-joint and flared copper water tube fittings and accessories. The booklet describes how to make solder-joint and flared connections and outlines advantages of copper water tube for plumbing, radiant heating, drainage lines, refrigeration, air conditioning, and compressed air lines.

278 GEAR REDUCERS, INCREASERS

Lufkin Foundry & Machine Co.—Catalog G-4 covers engineering and dimensional data on standard lines of slow and medium speed herringbone gear reducers of single and double reduction type and high speed herringbone gear units for speed reducing or speed increasing service. Engineering data on selection of size is given.

279 DEMINERALIZING

Cochrane Corp.—A 40-page "Handbook on Demineralizing" compares various methods of water treatment, and demineralizers and evaporators. Characteristics of various types of cation and anion exchange materials are discussed and data on operating costs is included.

280 HYDRAULIC FLUIDS

Vickers Inc.—A 24 page catalog, No. 1300SA, describes the selection, operation, and maintenance of hydraulic fluids for industrial machinery. It contains information on general qualities, lubricity, viscosity, viscosity index, oxidation resistance, neutralization number, rust and corrosion, demulsibility, foam, cavitation, additives and fire-resistant fluid selection.

281 REPRODUCTION MATERIALS

Eastman Kodak Co.—A booklet outlines ways in which Kodagraph reproduction materials can provide short cuts and savings in reproduction departments, drafting rooms, and in the field. The 12-page booklet diagrams seven applications for the materials.

282 SHAFT MOTION INDICATORS

Bin-Dicator Co.—Catalog describes and illustrates Roto-Guard shaft motion indicator, a compact, low-cost unit for attachment to machines in process and other industries to give positive indication of motion, slow-down or stoppage of machinery. Can actuate signals, controls. Dimensional drawings, mounting details are included.

283 MACHINERY LUBRICATION

Lubriplate Div., Fiske Bros. Refining Co.—A 36-page data book gives information on proper lubrication of all types of machinery. Included is data on improvement of machine operations, reduction of power consumption and lowering of maintenance costs through specialized lubricants.

284 PACKINGS, GASKETS

Crane Packing Co.—A 12-page booklet illustrates and describes the firm's Teflon mechanical and hydraulic packings, sheets, rods, tubing, tape, flexible bellows, gaskets, custom molded and machine parts, electrical and electronic parts.

285 RARE, REACTIVE METAL TUBING

Damascus Tube Co.—A 44-page handbook presents information on rare and reactive metal tubing for application in the chemical, nuclear and missile fields. Zirconium, Zircaloy 2 and 3; Titanium 40, 55, and 70; precipitation hardening steels—A-286, 17-7-PH, 15-7-MO; and Hastelloys A, B, C, F, and X are covered. A wall chart containing comparative corrosion effects of 44 common corrosive solutions is also available.

286 REDUCTION CRUSHERS

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin 58-D illustrates and describes the company's line of reduction crushers giving tables and dimension drawings. Capacities and performance data and installation photographs are included.

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LATEST INDUSTRIAL LITERATURE

287 CONVEYOR SYSTEMS

Fuller Co.—Bulletin G-3B, 12 pages, pictures and describes pneumatic conveying systems for handling dry, pulverized and granular materials. Diagrams show how systems work, and rotary compressors, vacuum pumps, horizontal grate coolers, Homboldt preheater, Sutorbilt positive pressure blowers, gas pumps, Lehigh induced draft fans, dynamic hot gas washers are covered.

288 FLASH BUTT-WELDING RINGS

American Welding & Mfg. Co.—A 20-page illustrated booklet describes how the firm produces rings and circular products. Photographs, drawings, and charts illustrate the methods used to form bar stock by bending and how it is welded to produce rings used in aircraft, missile, and other industrial applications. Specifications peculiar to flash butt-welded rings, quality control procedures, and testing are discussed.

289 HYDRAULIC HOSE

Flexonics Corp.—A 24-page catalog shows pressures and sizes of hydraulic synthetic hose. Fittings and factory crimped and field attachable types are included.

290 UNIT HEATERS

Grinnell Corp.—Catalog 58 illustrates and describes gas fired unit heaters. Information is given on unit location, mounting heights, length of throw, performance, specifications, weights, and dimensions.

291 BRONZE BEARINGS

Bunting Brass & Bronze Co.—Catalog 258 lists 343 stock sizes of cast bronze electric motor bearings for all makes and sizes of electric motors. These are made exactly to dimensions of original equipment and fit without further finishing.

292 PNEUMATIC CONVEYORS

National Conveyors Co.—Four-page Bulletin P58G describes pneumatic conveyor systems for handling bulk materials such as polyethylene and other types of plastic pellets, lime, alum, glass cullet, fine metal chips and borings, small parts and press scrap."

293 RUST PREVENTION

Rust-Oleum Corp.—A general catalog contains 109 color chips showing colors available in primers, short oil type coatings, oil field finishes, restful color group finishes, machinery and implement colors, long oil type coatings, Galvinoleum coatings, heat resistant coatings, chemical resistant coatings, floor and deck coatings.

294 HUMIDIFICATION EQUIPMENT

Bahnson Co.—Catalog Section 104 details the firm's line of industrial humidification equipment. Information and pictures describe and show various types of steam and water humidification equipment. The different uses, capacity, function, and operation of each type is explained.

295 MAGNETIC FLOW METERS

Foxboro Co.—Bulletin 20–14C describes two new magnetic flow meters for different flows. Developed for $^1/_{16}$ and $^3/_{16}$-in. lines, they measure full scale flow rates as low as 0.1 gpm, and are said to be useful in ratio flow control and pilot plant applications. Bulletin includes specifications and instrument data.

296 SCREW DRIVING ACCESSORIES

Magna Driver Corp.—A 27-page catalog gives specifications, diagrams of various permanently magnetic screw holding accessories for power drivers, and nut setters. Also included are magnetic hand screw drivers, sockets, and screw driver bits.

297 PROPORTIONING OIL BURNER

Anthony Co.—Data sheet 501 describes Nebulyte proportioning oil burner, Type BI, and includes capacity table, dimension drawings, application sketches, and installation photographs. Also available are Data sheets BA, BD, and BL covering low and high-range oil burners and BG-H covering combination gas-oil burners.

298 UNDERGROUND PIPE INSULATION

Zonolite Co., Z-Crete Div.—A 12-page brochure gives data, drawings, typical installations on Z-Crete, a monolithic, cast-in-place underground insulation.

299 CONVEYOR BELTING

Manhattan Rubber Div., Raybestos-Manhattan, Inc.—A 12-page brochure covers new conveyor belting. Drawings are used to describe the compensation and other features. Pages are arranged to represent and actual cross-section of the belt. It is claimed no breaker fabric is required with this belt, which means more thickness of the cover is utilized.

300 AIR CONDITIONING UNITS

Clarage Fan Co.—Catalog 1309 has 40 pages covering Design 1 Draw-Thru multitherms. By various arrangements of standard components these units can be used for applications ranging from simple ventilation to multi-function conditioning. Vertical and horizontal and sprayed coil units are shown.

Read the various items listed . . . one catalog may hold the solution to your present problem . . . and select those of interest to you.

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301 ELEVATED STEEL TANKS

Pittsburgh-Des Moines Steel Co.—Illustrated catalog on modern water storage contains information on dimensions and capacities of various types of elevated tanks: double ellipsoidal, obloidal, tripod sphere, pedestal sphere, radial cone, and hemispherical bottom. It also shows cutaway section of an elevated tank, illustrating construction details and accessories.

302 PLASTIC SHIMS, GASKETS

Chicago-Wilcox Mfg. Co.—Form 570 gives characteristics on plastic shims, gaskets, and shim stock. Data on color coding by thickness and results of testing the material is included.

303 INDUSTRIAL TRACTOR SHOVEL

Materials Handling Div.—Yale & Towne Mfg. Co.—Catalog No. 5255 provides construction data and specifications on Y-18 industrial tractor shovel with 2500-lb carry capacity, 8-ft dumping clearance, fully automatic torque transmission and fast cyclic rate of operation.

304 BIN LEVEL CONTROLS

Bin-Dicator Co.—Catalog describes and illustrates bin level indicators including new Roto-Bin-Dicator unit. Dimensional drawings, mounting details, typical applications, wiring diagrams, and list of present users are included.

305 WORM GEAR DRIVES

Cleveland Worm & Gear Co.—A 16-page, illustrated brochure provides information on the firm's standard line of speed reducers, worm gear sets and special units.

306 PNEUMATIC INSTRUMENTS

Republic Flow Meters Co.—Six specification folios cover null-balance-vector pneumatic instruments for utility and process control systems. Described are controller, pressure transmitter, differential pressure transmitter, temperature transmitter, and ratio relays.

307 DRAINLINES

Corning Glass Wks.—Eight-page, two-color bulletin on Pyrex pipe for drainlines contains case histories. Photos show installations, methods of installing, fittings available, ways to fabricate odd lengths on the job. Check list of acids to which the pipe is resistant is also included.

308 TEMPERATURE CONTROLS

Fenwal Inc.—Detailed folders describe devices for temperature detection, indication and control. Included are Thermoswitch and snap action local controls, remote bulb and capillary units, Detect-a-Fire and electronic thermistor controllers.

309 CENTRIFUGAL CASTINGS

Sandusky Foundry & Machine Co.—Catalog No. 200 explains how the centrifugal method produces a fine-grain, dense structure free of gas bubbles, slag, and non-uniformities, with desirable physical properties for circular or symmetrical parts. The firm's facilities for producing and machining cylinders in sizes from 7 to 54 in. OD, light or heavy-walled up to 33 ft in length, are described. Comprehensive alloy tables list characteristics of more than 70 stainless steel, steel, and nonferrous alloys available, and 86 present applications in 13 major industries are given.

310 TORQUE WRENCH SLIDE RULE

P. A. Sturtevant Co.—A slide rule for calculating conversion factor for torque wrenches used with adapters and extensions is offered. Range of rule covers practical torque wrench and adapter combinations for determination of proper conversion constant.

311 BELT CONVEYORS

Transall, Inc.—Four-page brochure outlining the advantages of Transall prelubricated belt conveyor idlers. A check point list is included.

312 SELF-LOCKING SCREWS

Standard Pressed Steel Co.—A 16-page booklet on self-locking socket head cap and set screws describes self-locking insert, gives specifications and performance data on material. Sizes, dimensions and packaging information is included.

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GUIDE

313 WATER SOFTENERS

Permutit Co.—Bulletin 2386-B describes trouble caused by using hard water. Equipment specifications, operating characteristics, data on ion exchange resins and typical installation photographs are included.

314 DIRECT CONNECTED FANS

Robbins & Myers Inc.—A 12-page pamphlet summarizing the design features and component parts of the Propellair fan. Included also are pictorial descriptions of some typical installations. In addition performance data for Propellair axial flow fans in charted. Also described is the Sky-Blast power roof ventilator.

315 METAL GASKETS

Chicago-Wilcox Mfg. Co.—Form 569 illustrates and describes corrugated metal, asbestos-cord-filled, and plain solid self-sealing gaskets. Drawings show installation procedures.

316 MULTI-V DRIVES

Worthington Corp.—A 100-page master engineering manual presents a scientific and simplified method for rating V-belts. Tables on drive selection contain nearly every possible stock sheave combination. Information on products and range of stock size sheaves with bore limitations is included.

317 FIRED INDIRECT HEATERS

Brown Fintube Co.—Bulletin No. 567 covers the applications, advantages and types of fired indirect heaters for air, special atmospheres, corrosive and non-corrosive gases, thermal chemicals, circulating oils, asphalt, and for super heating vapors.

318 BALL BEARING SWIVEL JOINTS

Chiksan Co.—A revised 32-page catalog, G-4R covers the company's line of ball-bearing swivel joints, loading racks, manifolding lines, all-metal marine and barge hose, and flexible aircraft assemblies. Typical industrial applications are illustrated and dimensional and operating data is provided.

319 LIGHT WEIGHT WELDING FITTINGS

Tube Turns—Bulletin TT867 gives specifications and allowable working pressures for carbon steel light weight welding fittings from 4 through 24 in. Its economies are described as lower material cost, labor saving, and increased efficiency.

320 WATER COLUMNS, GAGES

Ernst Water Column & Gage Co.—Bulletin 8-13-58 illustrates and gives specifications of bronze gages, flow indicators, water columns, steel gages and valves, gage glasses and gaskets.

321 O-RINGS

Linear Inc.—Compact 16-page folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes contain general recommendations on clearances, design material, machining, and finishes for most O-ring applications. A special compound bulletin describing the latest polymers and synthetic rubbers from which O-rings can be molded is also included.

322 CONDUIT SYSTEM

Stillwater Clay Products Co.—Newest development in underground piping layouts, the "one over one Cert-A-Bar conduit system" is described in a one-page, illustrated information sheet. Advantages of this system in steam and condensate systems, and in high-temperature water systems are listed and explained.

323 SCREW THREAD STANDARD

O-Vee Gauge Co.—"Screw Thread Standard H.28" has been revised and reprinted and issued Sept. 1957. New gaging requirements are discussed and described in a brochure, illustrated by diagrams.

324 VALVELESS FILTER

Permutit Co.—Bulletin No. 4351 describes the company's automatic gravity sand filter for municipal or industrial water treatment. The unit uses no valves, pumps, or flow controllers, and is said to cost less than conventional manual filters, reduce costs of installation, operation, maintenance and expansion, and produce uniform high-quality effluent. Sizes up to 400 gpm are available.

325 GEAR REDUCERS

Lovejoy Flexible Coupling Co.—Form R-58 illustrates and describes 18 models of shaft mounted gear reducers in speeds of 8 to 425 rpm, fractional to 120 hp, ratios of single 4.5:1 nominal and double 14.7:1 nominal, and with hollow shafts of $1\frac{7}{16}$ to $5\frac{13}{16}$ in.

326 BRONZE BEARINGS

Bunting Brass & Bronze Co.—Catalog 58 lists 866 sizes of standard stock cast bronze bearings, 667 sizes of plain, flange and thrust sintered oil-filled bronze stock bearings, 267 sizes of cast bronze tubular and solid 13-in. bars, and 84 sizes of sintered oil-filled bronze 6-in. bars.

327 PRESSURE SENSITIVE INSTRUMENTS

Wallace & Tiernan Inc.—Eight-page publication TA-1006-A gives specifications and range charts on absolute pressure indicators; gage, vacuum and differential pressure indicators; mercurial manometers; pressure control equipment.

328 TRANSDUCERS

Consolidated Electrodynamics Corp.—A 16-page folder, No. 1308, on transducers and associated equipment, illustrates and describes vibration pickups, velocity pickups, torsiographs, pressure pickups, dynamic pressure pickups, galvanometers, and telemetry equipment.

329 CUSTOM GEARS

Cincinnati Gear Co.—Illustrated folder describes and shows examples of types of gears produced to individual specifications only for all types of machinery and products. Gear types listed include spur, helical, rack, worm, herringbone, bevel, spiral bevel, internal, sprocket, Zerol (R) bevel and Coniflex (R) bevel; also custom gear boxes.

330 PNEUMATIC CONVEYING SYSTEM

Spencer Turbine Co.—Bulletin No. 143-B describes stationary and portable pneumatic conveying systems. Systems cover a capacity range from $\frac{3}{4}$ through 10 tons per hour; vacuum producers from 5 through 75 hp, and hose or pipe sizes from 2 through 7 in. Conveying under both pressure and vacuum is covered, and applications are illustrated. Specific information is provided on size of unit, rate of conveying, and type and weight of material in each case.

331 GAGES AND THERMOMETERS

Marsh Instrument Co.—Catalogs No. 76-G and 76-T describe in detail a wide line of industrial gages, needle valves, and thermometers. The catalogs are fully illustrated, including cut-away photographs and enlargements of internal parts. They cover also gage accessories, specifications including line drawings and dimensional tables, and templates covering every size and pattern.

332 DRAFTING AID

Stanpat Co.—Circular available describing the firm's printed adhesive-backed acetate sheets for speeding of drafting. These sheets are attached to original drawings and save draftsmen from redrawing standard details and repetitive notes. Resulting prints are clear and sharp and save tremendous amount of time.

YOUR *New Catalogs* GUIDE — LATEST INDUSTRIAL LITERATURE

333 COLD ROLL FORMING

Yoder Co.—An 88-page reference manual on cold roll forming covers operating speeds, tooling, personnel training and operating techniques, surface finish, uniformity, forming of pre-coated stock, selecting proper equipment.

334 ELECTRONIC AIR CLEANING

Westinghouse Electric Corp., Sturtevant Div.—Supplement Catalog 1460 illustrates electronic air cleaning section with motorized washer and adhesive applicator. Capacities and dimensions are listed for 13 sizes for unitary installation or in-line assembly with air distributing units. It is designed specifically for application at normal cooling coil face velocities for central plant air conditioning, heating, and ventilating.

335 CONVEYOR-ELEVATORS

Stephens-Adamson Mfg. Co.—Catalog 358 illustrates the firm's line of conveyors, elevators. Typical arrangements are diagrammed; power requirements, specifications and installation data is given. Applications in various industries are illustrated and described.

336 SURFACE CONDENSERS

Worthington Corp.—Bulletin W-200-B3A shows applications of surface condensers for steam power stations, industrial processes, marine and water works service.

337 DUST FILTERS

W. W. Sly Mfg. Co.—A 36-page Bulletin 104 describes dust filters and gives engineering information on dust control systems. Operating principles of the firm's Dynaclone are described, and dust filter system specifications and hopper and support data are included.

338 PROCESS HEATERS

Pantex Mfg. Corp.—Bulletin 38-D illustrates and describes Speedytherm process heaters for high temperature, low pressure applications. The method circulates liquid at temperatures up to 500 F for heating presses, platens, rolls, and jacketed kettles.

339 STOCK GEARS

American Stock Gear, Div. of Perfection Gear Co.—Catalog No. 360 contains information and engineering data covering brass, bronze, steel, semi-steel, cast iron, and nonmetallic gears in a range of 48 to 3 diametral pitch.

340 CLAD STEEL EQUIPMENT

Lukens Steel Co.—A 28-page booklet covers the development, manufacture and properties of clad steels, the types of cladding materials available, design considerations, fabrication techniques and clad steel equipment applications.

341 MACHINE TOOLS, LATHES

R. K. LeBlond Machine Tool Co.—Catalog describes and illustrates machines by the builder of a complete line of lathes. Heavy duty, roll turning, tool room, standard duty, sliding bed gap, hollow spindle, rapid production, crankshaft, regal, dual drive lathes and new rapid borer are reviewed. Included also is the firm's Hydra-Trace duplicating attachment.

342 AIR-GRAVITY CONVEYOR

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin 58-K illustrates and describes air-float conveyor for air-gravity conveying of dry free-flowing materials. Of principal interest to the cement, lime, and chemicals industries, the unit uses an exclusive porous plate for the conveying surface.

343 INSPECTION INDICATING GAGES

O-Vee Gauge Co.—Bulletin illustrates and describes new line of heavy rugged indicator gages with lever type amplification which provides greater reliability. Provision is made to enable gaging fixtures and stages to be made at low cost. Examples are illustrated in the bulletin.

344 NEW METHOD OF LUBRICATION

Stewart-Warner Corp., Alemite Div.—Catalog describes new method of lubricating industrial machinery with "Oil-Mist." Bulk of publication taken up with engineering data, covering applications, operation, bearing application, bearing speeds of this method. Also for plain bearings, selection of condensing fittings, intermixing of condensers, bearing grooving and many other engineering data appropriate to the subject.

345 VARIABLE SPEED DRIVES

Sterling Electric Motors, Inc.—An 8-page bulletin illustrates and describes variable speed drives for metal working, mixing, pumping, materials handling and continuous processing. Engineering, selection and operating data is included.

346 HEATING, AIR CONDITIONING

Surface Combustion Corp.—A 28-page brochure describes equipment engineered and built by Surface Pelletizing, Steel Mill, Heat Treat, Glass, Webster Engineering Co.—Boiler Burner, Kathabar Air Conditioning and Drying, Janitrol Aircraft and Janitrol Heating, and Air Conditioning divisions.

347 FLOAT, THERMOSTATIC TRAP

Warren Webster & Co.—Bulletin B-1205 describes a new series of float and thermostatic traps for steam pressures to 150 lb per sq in. Traps are now made with 3/4, 1 and 1 1/4 in. connections. Bulletin gives construction details, ratings and suggested specifications.

348 WATER CONDITIONING

Permutit Co.—A 12-page bulletin, No. 4433, is a general discussion of the major types of water treating equipment—filters, zeolite softeners, precipitators, chemical feeders, demineralizers. Each equipment type is illustrated and discussed briefly. Water impurities and their general methods of removal are tabulated and typical water-treatment systems for municipalities, utilities, and industries are illustrated.

349 DRY FLUID DRIVES

Dodge Mfg. Corp.—Bulletin A640B, 24 pages, contains general information, installation, and product photographs and engineering drawings on Flexidyne dry fluid drives and couplings. New expanded line includes sizes to deliver from fractional to 1000 hp.

350 ROTARY SLITTING LINES

Yoder Co.—A 75-page handbook provides information on slitters and allied equipment. Basic data on design, selection and operation of slitting lines, and specifications of slitters, uncoilers, recoilers, coil cars, and scrap choppers are included.

351 COMBUSTION EQUIPMENT

Hauck Mfg. Co.—The Catalog 52 gives a condensed and pictorial review of oil and gas combustion equipment for production, construction, and maintenance applications in industry. The catalog has 12 pages and 80 illustrations.

352 DEAERATORS

Permutit Co.—Bulletin No. 2357 describes the company's spray type deaerating heater. The principles of deaeration and the part it plays in corrosion prevention are described and illustrated. The deaerating heater is designed to protect equipment from corrosion by removing oxygen, carbon dioxide and nitrogen.

353 CHART PAPERS

Technical Charts, Inc.—A revised set of "Technical Notes" includes 16 different bulletins describing specifications for standard and special recording charts. Subjects cover various types of paper available, including heat-sensitive and electro-sensitive, strip chart core and punch sizes.

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LATEST INDUSTRIAL LITERATURE

354 BELT CARRIERS

Stephens-Adamson Mfg. Co., Standard Products Div.—Bulletin 355 lists carriers for belt conveyors and shows their application in industry. Cross sections and dimension tables are given for the various carriers.

355 AIR CONDITIONER

Westinghouse Electric Corp., Sturtevant Div.—Catalog 1635-B illustrates multi-zone units for central plant air-conditioning systems. They supply air mixtures, blended for simultaneous unequal heat load demands, in various zones requiring individual temperature and humidity control. Seven basic sizes, 4000 to 34,000 cfm.

356 SELF-CLEANING CENTRIFUGE

Pfaudler Co., Div. of Pfaudler Permutit Inc.—Bulletin 946 presents information on its Titan superjector, an automatic self-cleaning centrifuge. Engineering information, specifications and application data are given, along with details on the operation of the unit.

357 MAINTENANCE IDEAS

Kano Laboratories—An alphabetical list of ideas gathered from the correspondence of industrial customers deals with problems in lubrication, stuck together metal parts, difficult metal cleaning, and lubrication of air driven tools.

358 CONVEYOR BELTING

Manhattan Rubber Div., Raybestos-Manhattan, Inc.—Catalog 25CB illustrates and describes conveyor and elevation belts. It covers new style designations of general service heavy duty types made with special strength numbers. Tension ratings, minimum pulley diameters and minimum belt widths are given.

359 CENTRIFUGAL FANS

Ilg Electric Ventilating Co.—Type BC centrifugal fans with airfoil blades, aluminum sides and scroll, in both direct-connected and belted models for ventilating and heating equipment are illustrated and described in eight-page Bulletin S317. Performance, dimensions and capacities are given for each type with detailed drawings.

360 NAMEPLATE MARKING

Jas. H. Matthews & Co.—An eight-page bulletin illustrates and describes nameplate marking equipment from steel hand stamps to production machines.

361 SPEED REDUCERS

Cone-Drive Gears Div., Michigan Tool Co.—Details of double-enveloping worm gear speed reducers are presented in 24-page Bulletin CD-218. Stocked capacities of the line range from fractional to 665 hp, reductions from 5:1 to 70:1. Specifications on extended shaft and shaft mounted models, dimensioned assembly drawings, tables of mechanical and thermal hp, output torque and chain pull ratings are included.

362 AUTOMATIC LIQUID LEVEL GAGES

Liquidometer Corp.—Bulletin 463A describes 100 per cent automatic remote reading tank gages. Included is information on direct reading gages at tank and hydrostatic type remote reading gages.

363 GLASS FIBER INSULATION

L-O-F Glass Fibers Co.—Illustrated brochures outline advantages of both Microlite and Superfine glass fiber insulations, low-density resilient insulating materials with high thermal efficiency and round absorption characteristics. They are described as being resistant to heat, fire, moisture, and corrosion and the company recommends their use in applications where the greatest thermal and acoustical efficiency is desirable in the smallest space. Tables are included on thermal and acoustical performance.

364 DRAFTING MACHINES

Charles Bruning Co.—"The Finest in Drafting Machines," a 20-page illustrated booklet, explains the cost and time-saving advantages offered by drafting machines in mechanical drawing, and describes and illustrates models and construction features. A list of available scales is included.

365 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—A new 24-page, 3-color catalog, illustrated with comprehensive specifications on more than 500 types and sizes of standard miniature ball bearings from .059 in. to $^3/_8$ in. OD, includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

366 VIBRATING FEEDERS

Syntron Co.—A 30-page catalog covers standard and special model electromagnetic vibrating feeders for hard-to-handle bulk materials. Descriptions, data, and specifications are included along with installation photos and application diagrams.

367 KILN INSTRUMENTATION

Leeds & Northrup Co.—A 16-page folder illustrates and describes instruments and controls for rotary kilns used in the manufacture of cement, lime and other non-metallic products. Installation photos are included.

368 LOADING ASSEMBLIES

Jordan Industrial Sales Div. of OPW Corp.—A 24-page Catalog F-32R describes loading assemblies and accessory products. The catalog contains detailed product descriptions and photos, engineering information, dimensional drawings, installation layouts, and selection instructions.

369 TITESEAL COMPOUNDS

Radiator Specialty Co.—Brochure, 12 pages, describes Titeseal Pipe-sealing Compounds and the part they are playing in American Industry. The book gives properties and recommended uses.

370 AIR CONDITIONING, REFRIGERATION

Curtis Mfg. Co.—A four-page brochure covers entire line of air conditioning and refrigeration equipment. It illustrates and gives specifications on packaged air conditioners 3 to 50 tons, air cooled air conditioners 3 to $7^1/_2$ tons, packaged liquid chillers $7^1/_2$ to 100 tons, condensing units $^1/_4$ to 100 hp, cooling towers, evaporative condensers, air cooled condensers, air handling units.

371 SPRING PINS

C. E. M. Co.—Catalog lists prices, dimensions, technical information on heavy, medium, and light duty Spirol spring pins in carbon steel, chrome stainless steel, and nickel stainless steel. Typical applications are illustrated.

372 UNDERGROUND PIPE INSULATION

American Gilsonite Co.—A four-page bulletin gives tips on the uses and installation of a new insulation for hot underground pipes. It explains how the material protects pipes against corrosion caused by acids and alkaline ground waters, and against bacterial action, roots and electrolysis.

373 BEARINGS, BUSHINGS

Cleveland Graphite Bronze Div., Clevite Corp.—A 16-page catalog gives data on engineering, material analyses and applications of bearings, bushings, wear plates, thrust bearings.

374 PLASTIC RESINS

E. I. duPont de Nemours & Co.—Catalog A-7345 illustrates and describes characteristics, forming and working techniques and end-use applications of Teflon tetrafluorethylene resins, Zytel nylon resin, Alathon polyethylene resins and Lucite acrylic resin. Detailed properties charts are listed.

375 DRAFTING ROOM EQUIPMENT

Hamilton Mfg. Co.—Catalog No. 15 lists steel and wood drawing tables and files for every drafting room need. It includes comprehensive data on the Auto-Shift drafting table, and information about the "L" table and shallow-drawer unit with tracing lifter plus new Hamilton-Pack interlock files.

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376 OPEN-DIE FORGINGS

Alco Products, Inc.—Eight-page bulletin describes company's $4½ million open-die forging facilities at Latrobe, Pa. Plant produces open-die forgings in variety of shapes and in sizes from 300 to 30,000 lb from the firm's carbon and leaded steels. Extensive test procedures applied to all forgings are outlined.

377 MILLING, GRINDING MACHINES

Cincinnati Milling Machine Co.—Illustrated catalog of 72 pages describes and gives specifications on the firm's line of machine tools for milling grinding, broaching, cutter and tool grinding, and special machine tools. Machines for selective hardening and metal forming are covered and information about the firm's grinding wheels and cutting fluid is given.

378 STAINLESS STEEL FITTINGS

Ladish Co.—An 86-page master reference volume on stainless steel pipe fittings gives information on broad line of IPS and tube OD fittings, ASA, MSS and corrosion weight flanges. Technical section includes manufacturing standards, specifications, corrosion resistance tables, and data on welding of stainless steel.

379 SOLIDS—CONTACT REACTORS

Cochrane Corp.—A 24-page bulletin on solids-contact reactors contains a cut-away photograph and several pages of plan and elevation drawings showing the variety of designs available. The bulletin discusses theory and problems of cold water clarification, advantages and applications of various designs. Auxiliary and supplemental apparatus is described.

380 ROTARY BLOWERS

Roots Connersville Blower Div., Dresser Ind.—Bulletin AF-258 describes rotary positive blowers 7-in. gear diameter and smaller. They are rated from 1 to 7 psig and will handle from 10 to 700 cfm of air. Eighteen standard sizes are listed.

381 CENTRIFUGAL CASTINGS

Sandusky Foundry & Machine Co.—Bulletin 200 contains tables on the composition and specifications of heat, corrosion and abrasion resistant alloys and plain carbon and low alloy steels and nonferrous compositions available in centrifugal castings manufactured by the company.

382 ANALYZERS, INSTRUMENTS

Panoramic Radio Products, Inc.—A catalog digest gives specifications and dimensional information on spectrum analyzers, special purpose and accessory instruments and telemetering test instruments. A summary of applications is also included.

383 LUBRICATION APPLICATIONS

Bijur Lubricating Corp.—Bulletin NB-20 gives case histories of lubrication systems in machine tool operations. Photos of various machines featuring the firm's lubrication systems are included.

384 GAGING CARTRIDGES

Sheffield Corp.—A 32-page booklet gives application data on the use of Plumjet air gaging cartridges with instruments. Included are types, sizes, amplification tolerance, and range of the units. Engineering and technical data for applying them to single and multiple dimension inspection and machine control is included.

385 TROLLEY CONVEYOR SYSTEMS

Conveyor Systems, Inc.—An eight-page brochure presents information and photos on power and free trolley conveyor systems. The equipment is designed for industries which can advantageously employ free-running line branches from main circuit of power conveyors.

386 AIR METHOD PROCESSING

Niagara Blower Co.—Bulletin 135 illustrates and describes apparatus using the air method to remove heat from liquids or vapors for process cooling, flash cooling, vacuum distillation, condensing, refrigeration, and air liquefication.

387 ROLLER BEARINGS

Hyatt Bearings Div., General Motors Corp.—Catalog 150 illustrates and describes solid roller bearings, wound roller solid race and split race bearings, industrial inch bearings and solid roller bearings in separable inner race, separable outer race and nonseparable types.

388 ALUMINUM FABRICATION

Aluminum Co. of America—A 12-page booklet illustrates and describes the engineering, fabricating, welding, finishing, testing, and inspecting facilities at the firm's jobbing division.

389 ASH SLUICING SYSTEM

United Conveyor Corp.—A four-page bulletin, No. 1S-57 describes recirculating closed circuit ash sluicing system with description of principle and sequence of operation.

390 BALL BEARINGS

New Departure Div., General Motors Corp.—A 36-page booklet illustrates and describes miniature precision instrument ball bearings. Data is given on each series, along the engineering and performance information.

391 LOW TEMPERATURE HEAT RECOVERY

Green Fuel Economizer Co.—Illustrated folder describes construction and operation of the firm's latest cast-iron economizer, which has been specially designed for low temperature heat recovery from flue gas under adverse conditions. A circuit diagram shows one of several alternative methods of transferring the recovered heat back into the system.

392 LAMINATED PLASTICS

Formica Corp.—A condensed catalog of technical information describes services and product areas of the company's industrial products section. Included is information on Copperclad laminates, laminate sheet sizes, moldings, rods, tubes post-forming, and special NEMA and special grade charts and a comparator chart.

393 METAL HOSE

Flexonics Corp.—A 36-page design catalog covers application and selection of metal hose. Various end fittings are illustrated and described.

394 HUMIDITY CONDITIONING

Surface Combustion Corp.—A booklet outlines the advantages of industrial humidity conditioning to bring about higher production, lower costs, better products, reduced absenteeism. A considerable number of case histories are shown.

395 INSTRUMENTS, SYSTEMS

Gulton Industries, Inc.—A four-page scientific brochure covers the firm's instruments for shock, vibration, pressure, inertial control, temperature, and other devices for use as single components or in complete systems.

396 STORAGE TANKS

Hammond Iron Wks.—A 36-page catalog describes storage systems, including patented floating tanks of Tubeseal or Springtite construction, Vaporlift systems, Diaflote tanks, Dialift systems, underground storage tanks, water storage tanks and treatment vessels, and the recently introduced Hamondflote cover for small vertical tanks.

397 FRICTION MATERIALS

Johns-Manville—A 16-page brochure, FM-35A, gives descriptions, design data, characteristics, and a reference chart of industrial friction materials including asbestos brake blocks, linings, and clutch facings.

For Consulting Engineers Turn to Page 254

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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

398 BRONZE BEARINGS

Johnson Bronze Co.—A catalog lists and illustrates more than 900 sizes cast bronze bearings, 400 sizes of bronze bars, cored and solid, graphited bronze, powdered bronze in straight, flanged and self-aligning bearings, bearing babbitt.

399 FIN RADIATION

Moore Dry Kiln Co.—Bulletin 5308-R illustrates and describes a steel-finned pipe for heating and cooling applications. Surfaces are formed by spirally wound coils of heavy gage steel strip, corrugated on inner edge.

400 SPEED REDUCERS

Stephens-Adamson Mfg. Co.—Catalog 643 covers single and double reduction type speed reducers. Specifications and dimensions are tabled, and installation information is given. A section of the 12-page booklet deals with the firm's materials handling equipment.

401 GASKETS

Garlock Packing Co.—Bulletin AD-104 describes the firm's Guardian spiral wound metal gaskets. The bulletin details features and design factors of the metal gaskets as well as the types available for specific applications.

402 AVIATION PRODUCTS

Aluminum Co. of America—A 16-page report covers recent accomplishments in research and development of improved products, construction of new facilities and increased production efficiency to solve aircraft industry problems of production economy and weight control in aluminum components.

403 OIL, FLUID SEALS

National Seal Div. Federal-Mogul-Bower Bearings, Inc.—Catalog 58 covers selection, application, maintenance of 40 different types of oil and fluid seals. More than 3000 sizes are listed.

404 TOOL BITS

Firth Sterling Inc.—A catalog covers high speed steel tool bits. Typical analyses of five grades of high speed steel are included, with sizes, standard package quantities, weights per package, and prices. Authorized distributors are listed.

405 AIR COMPRESSORS

Gardner-Denver Co.—An eight-page bulletin illustrates and describes carbon piston horizontal single-stage air compressors for oil-free air in the processing, chemical and plastic industries.

406 GRATING-FLOORING AND TREADS

Irving Subway Grating Co., Inc.—Catalog F-400 contains illustrations, descriptions and engineering data on the grating-flooring, treads, and floor armoring (riveted, press-locked, welded types) for industrial and power plants and refinery walkways, stairways, driveways, trucking aisles; ship cat-walks and engine room floors and treads; locomotive, freight and passenger car runways and treads; roadway armoring expansion joints catch basin covers; bridge decking.

407 DRAFTING DESK

General Fireproofing Co.—A folder illustrates and describes a drafting desk which has a belt positioning control and incorporates a reference area and storage space in one compact unit.

408 DIAPHRAGM VALVES

Grinnell Co.—An 8-page catalog describes diaphragm valves offering streamlined fluid passage, flow control, leak-tight closure. Isolation of working parts from fluid stream is said to prevent product contamination and corrosion of operating mechanism. Flexibility of assembly and wide choice of materials for bodies, body linings and diaphragms are described.

409 OIL FILTERS, STRAINERS, OILING DEVICES

Wm. W. Nugent & Co., Inc.—Seven bulletins: No. 6 illustrates and describes Nugent pressure strainers; No. 7 gravity filters; No. 7A pressure filters; No. 8 tanks, pumps, shaft oilers; No. 14 oiling and filtering systems for turbines, paper mills, steel mills, pumps, compressors; No. 15 oiling devices; No. 16 sight feed valves, multiple oilers, flow indicators, sight overflows, and compression union fittings.

410 VIBRATION ISOLATION

Korfund Co.—A four-page bulletin gives information on how to write vibration isolation specifications for air conditioning and related equipment. It contains a definitive treatment of the factors involved in the selection of various isolation media commercially available and has a selector chart designed to simplify writing specifications. Bulletin F2C.

411 MACHINE DESIGN IDEAS

Lincoln Electric Co.—A series of pamphlets discusses basic approach to efficient design in steel. Current series covers fundamentals of design of component parts to simplify construction, also basic ideas of designing machine bases to increase rigidity and reduce cost.

412 HOLLOW FORGINGS

Babcock & Wilcox Co.—Bulletin S-16C gives specifications, surface finishes, materials reference tables, and shows production and finished products of hollow forgings.

413 HYDRAULIC LABORATORY PRESSES

Wabash Metal Products Co.—Catalog 158 describes hydraulic presses with heated platens for laboratory work. Presses both manually operated and self-powered hydraulic system are shown in from 3 to 50-tons capacity. Complete specifications are given, and accessories are shown.

414 BUTT WELDING PIPE FITTING

Bonney Forge & Tool Wks.—Literature describes a forged, integrally reinforced, insert butt welding pipe fitting specially designed for applications on high yield pipe in the oil and gas transmission industries. The Sweepolet is reported to provide optimum reinforcement, maximum efficiency of metal placement with minimum weld.

415 ELECTRICAL HEATING UNITS

Edwin L. Wiegand Co.—Booklet illustrating and describing 101 ways to apply electric heat and showing approved methods of electrically heating liquids, air, gases, machine parts and process equipment. All items are illustrated and described in detail and varied applications are shown. The heating units go under the trade name of Chromlox.

416 PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—Catalog sheets illustrate and describe hand operated punches, cutters, and benders and list large, planned stock of punches and dies to fit most makes of punch presses. New, simplified system of decimal die marking is introduced with charts for determining correct clearance to allow for both type and thickness of metal being punched.

417 SEALED BEARINGS

Stephens-Adamson Mfg. Co., Sealmaster Bearings Div.—Bulletin No. 758 illustrates and describes the firm's Sealmaster bearings. Standard and special units are available. Cutaway photos show such features as zone hardening, locking pin and perimeter dimple, labyrinth seal, ball retainer.

418 DRAFTING EQUIPMENT

A. W. Faber-Castell Pencil Co.—The company offers three bulletins outlining some of their drafting materials. Described in detail are the Castell slide rules and scales as well as the Locktite Fleetline Holder, guaranteed dust-free because there is no sharpening or sanding.

419 OIL LEVEL UNITS

Bijur Lubricating Corp.—Bulletin 8-E illustrates and describes window-units for mounting in machines to show the oil level. Specifications and dimensions of standard, level, and open types of units are given, along with installation data.

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New Catalogs GUIDE — LATEST INDUSTRIAL LITERATURE

420 PLUG VALVE LINES

Ohio Injector Co.—A valve catalog digest covers bronze, iron, cast steel, forged steel, and lubricated plug valve lines in a condensed form. Classified by type and pressure class, and illustrated, this edition also includes fact to face dimensions for each size and type of valve listed.

421 AMMONIA ABSORPTION REFRIGERATION

Black, Sivalls & Bryson, Inc.—Bulletin 33-10 illustrates and describes the firm's ammonia absorption refrigeration unit, an automatic system for the production of low temperatures for natural gas conditioning. The seven-page booklet contains specifications and diagrams. Eleven standard units are offered.

422 VERTICAL FOUR-SLIDE MACHINE

Torrington Mfg. Co.—Bulletin V-82 details operating features, specifications for new Verti-Slide all-purpose vertical four-slide machine. Design details and component functions are given for feed mechanism, cam and cam shafts, drive system, and presses. Photos illustrate operation of slides, slide bases, center former, lubrication system, and clutch.

423 GASKETS METAL RASCHIG RINGS

Metallo Gasket Co.—Bulletin No. 57 describes metal and metal combined with soft packing for use on high and low pressure service, metal tower packing made as Raschig and Lessig rings. Also included are washers, shims, and metal asbestos valve disks.

424 RAILROAD CAR SHAKER

Webster Mfg. Inc.—Bulletin 60D illustrates and describes the firm's car shaker, a cradle type unit weighing 3600 lb and powered by 10-hp motor. The shaker is capable of unloading coal, stone, gravel from hoppered bottom cars.

425 COPPER TUBING HANGERS

Grinnell Co.—A 12-page catalog, CTH-56, covers hangers and supports for copper tubing. All hangers are copper plated and accurately sized to fit standard copper tubing. Data is also included on packaged quantities.

426 MATERIALS HANDLING

Syntron Co.—A condensed catalog, No. 586, contains 64 pages of technical data, brief description and photographs of bin vibrators, vibratory feeders, vibratory conveyors, power tools, shaft seals, selenium rectifiers, vibrating parts feeders, heating elements and other equipment.

427 DRAFT GAGES, INSTRUMENTS

Ellison Draft Gage Co., Inc.—Bulletin 354-A gives a briefing on the entire line of the company's bell actuated and diaphragm actuated draft gages, inclined tube draft gages, pitot tubes gas analyzers, steam calorimeters and other boiler room and laboratory gages and instruments.

428 BALL BEARINGS

Federal Bearings Co.—Catalog D-1 contains 24 pages of dimensional tables for selection of ball bearings according to size, and assists in the identification of ball bearings for which a replacement is required. Both metric and inch measurements are shown. Catalog also includes interchange and conversion tables.

429 SYNTHETIC RUBBER

B. F. Goodrich Chemical Co., Div. of B. F. Goodrich Co.—"Everywhere in Industry—Hycar American Rubber," 24 pages, describes Goodrich Hycar rubber and its properties, using text and tables. General applications and uses are suggested for the different types and blends available.

430 THREAD INSERTS

Heli-Coil Corp.—Catalog on standard line of screw thread inserts designed for protection and repair of tapped threads in all materials is contained in Bulletin 652-A. Covered are design information, drilling and tapping recommendations, and specifications for various classes of fit. Also available is Bulletin 738 which provides similar details on new screw-lock insert which eliminates the need for lock washers, lock nuts.

431 MARKING EQUIPMENT

Jas. H. Matthews & Co.—Four supplements to catalog 146 include 21 pages describing hand marking stamps and tools; 16 pages describing steel marking dies; 19 pages describing marking machines; 17 pages describing identification checks, badges, tags.

432 LIQUID METERING EQUIPMENT

Black, Sivalls & Bryson, Inc.—The firm's line of fully automatic liquid metering equipment for handling lease produced liquids is outlined in a 24-page catalog. The line includes metering separators, chambers, tanks and test treaters. Any of the items may be used independently or as an integral part of the firm's lease system.

433 DUST, FUME COLLECTORS

Northern Blower Co.—Bulletin 164 describes automatic bag type arresters, diagrams standard dimension factors and supplies table of dimensions and capacities. Separate additional bulletins contain similar data for standard bag type (not automatic), hydraulic type, centrifugal type, and portable dust collectors.

434 DEEP DRAWN SHELLS

Pressed Steel Tank Co.—A bulletin summarizes basic applications and economies possible using seamless cupped and deep drawn ferrous and nonferrous shells. Included is information on head shapes and types of open ends available, practical diameter to length ratios, wall thicknesses.

435 SHELL-ICE MAKERS

Frick Co.—Bulletin 54-F covers automatic shell-ice makers in nine sizes from 2 tons. Ice is frozen in thicknesses of $^1/_8$ and $^1/_2$ in. on the outside of stainless steel tubes.

436 LIQUID LEVEL GAGES

Jerguson Gage & Valve Co.—Condensed catalog No. 335 illustrates standard and special function gages and valves, giving dimensional drawings, construction features, pressure-temperature graphs and ratings, materials, and tables of sizes, specifications and standard and optional features. Illustrated with photographs and drawings.

437 PROCESS INSTRUMENTATION

Fischer & Porter Co.—A 52-page catalog describes the company's products available for immediate shipment. Included are prices. It covers indicating, recording, controlling and transmitting instruments for flow, pressure, density and temperature.

438 BALL THRUST BEARINGS

Gwilliam Co.—Catalog No. 28 describes, illustrates and lists standard sizes of various types of ball thrust bearings, roller thrust bearings, and journal roller bearings.

439 VALVES, CONTROLS

Hays Mfg. Co.—A packet of data sheets covers the firm's lines of solenoid valves, controls, strainers and automatic interlocks. Specifications, dimensions and flow charts are given.

440 AIR CONDITIONING CONTROL

Niagara Blower Co.—Bulletin 122 describes and illustrates operation and suggests applications for an air conditioning method that controls humidity to 1 per cent RH and temperatures to 1 F.

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LATEST INDUSTRIAL LITERATURE

441 ASBESTOS-CEMENT BOARD

Philip Carey Mfg. Co.—Form 6285 describes asbestos-cement board for exterior walls, partitions, linings, utility structures. The material is not affected by most acids, alkalis, fumes, heat, cold, weather, salt air. It is vermin and rodent proof, will not rot, rust or corrode, and needs no paint or protective coating. It can be painted for decorative purposes. Suitable for continuous temperatures up to 600 F.

442 MECHANICAL PACKINGS, GASKETS

Raybestos-Manhattan, Inc., Packing Div.—Selected packing types designed for custom-built service on 95 per cent of all packing applications are the subject of this 40-page catalog. The book contains descriptions, illustrations, service recommendations, and specification charts that cover over 100 different products in packing and gasket materials.

443 MATERIALS HANDLING

Jeffrey Mfg. Co.—Catalog 911 offers a comprehensive study of the broad line of foundry equipment which Jeffrey manufactures. Subdivided into four separate sections, the book contains detailed specifications and line drawings supplemented by pertinent data and installation photographs. A feature of the catalog is the new "package" sand handling system just recently introduced.

444 COUNTING DEVICES

Veeder-Root, Inc.—Modern mechanical electrical, and electronic counters for all industrial and special counting requirements are briefly described in a four-page condensed general catalog. Also contains information on applications and how-to-order.

445 OPTICAL INSTRUMENTS

Bausch & Lomb Optical Co.—A booklet, "Industrial Optical Aids," contains information on an assortment of inexpensive precision optical instruments and suggests ways to use them to gain faster, easier, lower-cost production. Items discussed include magnifiers, microscopes, wide field tubes, macroscopes and comparators. Catalog D 1059

446 LEASE AUTOMATION SYSTEMS

Black, Sivalls & Bryson, Inc.—Packaged lease automation from wellhead to pipeline provided by the firm's new Phanto-Matic lease system, is described in a 20-page catalog. The system offers fully automatic wellhead shut-in control, well test control, well flow control, tank switching, custody transfer, fluid metering, and lease safety controls.

447 STEEL WIRE

American Chain & Cable Co., Page Steel & Wire Div.—A 16-page catalog, DH-1226, on Page shaped wire includes specification tables, range of sizes, physical properties of steel wire, table of standard wire gages, hardness conversion tables, with illustrations showing how to calculate areas of typical common shapes of wires. Size range includes cross-sectional area up to and including No. 3 BWG; flats and rectangles in widths up to $^3/_8$ in., the ratio of width of thickness not exceeding 6 to 1.

448 STRUCTURAL INSULATING PANELS

Philip Carey Mfg. Co.—Form No. 6301 provides data on a rigid, structural material that also insulates walls, roof decks, partitions. It is made by bonding asbestos-cement board to both sides of a specially processed asphalt-treated insulation board. The material is described as lightweight, water-resistant, approximately 60 per cent light reflectivity, won't rust nor rot and needs no preservative treatment or painting.

449 COPPER, COPPER ALLOY

American Brass Co.—A new edition of a 24-page reference manual contains copper and copper-alloy specifications, including ASTM, ASME, AWS, SAE, AMS, federal, military, Navy, and joint Army-Navy specifications.

450 METAL STAMPING

Stamping Div., Rockwell-Standard Corp.—An eight-page booklet describes Bossert's engineering and re-design service, illustrates complete facilities for producing large or small stampings and welded assemblies in any metal or alloy. Also illustrated are intricate stampings produced for a diversified group of metal products.

451 GLASS-BONDED MICA

Mycalex Corp. of America—A revised engineering data file, contains technical information, design considerations and suggested applications of the company's Supramica ceramoplastic and Mycalex glass-bonded mica products. Charts of electrical and thermal characteristics and tabular data on the physical properties of the materials are included.

452 PIPE HANGERS

National Valve & Mfg. Co.—Bulletin 157 gives specifications for Counterpoise hangers, designed to provide a constant load supporting capacity for piping systems subject to vertical movement caused by expansion and contraction of piping with temperature changes. Leveiglide hangers, which permit horizontal movement of piping systems, also are described.

453 DEMINERALIZATION

Graver Water Conditioning Co.—Bulletin WC-111A covers the application of demineralizers, their basic principles of operation and the chemistry of ion exchange resin. Information and charts on materials of construction and the design of component parts is included.

454 CARBIDE TIPS

Firth Sterling Inc.—New 56-page catalog on carbide tips, tools, and inserts. A picture index identifies each product, and the pages have been die cut to expose the beginning of each section. A grade selection chart is included. Authorized distributors are listed.

455 VIBRATING FEEDERS

Carrier Conveyor Corp.—Natural frequency mechanical vibrating feeders are illustrated and described in Bulletin No. 1001. No complicated electrical equipment is used in these feeders which come in standard widths to 72 in. and lengths to 12 ft. Special high temperature models for 1800 F material are available. All models are available with fixed or variable feed rate drives.

456 PRESSURE GAGES

American Chain & Cable Co., Helicoid Gage Div.—The 24-page Helicoid gage catalog describes the Helicoid gage as guaranteed accurate to within $^1/_2$ of 1 per cent of the total dial graduation over the upper 95 per cent of the 270-deg dial arc. Cutaway photographs and line drawings show the complete line of Helicoid gages.

457 FLEXIBLE COUPLINGS

Poole Foundry & Machine Co.—A 136-page manual illustrates, describes and gives engineering specification and lubrication data on flexible couplings.

458 CONDENSER TUBES

American Brass Co.—A 44-page manual on selection of condenser tube and tube sheet materials discusses the application and installation of copper and copper alloy condenser and heat exchanger tubes, plates for tube sheets heads and baffles. Included is a review of corrosion factors in condenser tube service.

459 AIR COCKS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes plug type and diaphragm type two and three-way cut-out cocks for pneumatic systems.

460 REFRACTORIES

Carborundum Co.—Bi-monthly bulletins about refractories, their properties, uses and recent developments, are available. Subjects covered include muffled constructions, brickwork construction, research and development, a new silicon carbide refractory, wear resistance refractories, hot strength, heat resistance of refractories, thermal-shock resistance, chemical resistance, and stability.

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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

461 MOTION PICTURE CAMERAS

Wollensak Optical Co.—A catalog explaining high-speed photography, its application and the results obtainable and a folder describing the operation and uses of the Fastax high-speed motion picture-oscillographic camera are available. These cameras, used in research, design, commercial engineering, are a continuous moving film type with rotating prism positioned between the lens and the sprocket. They are available in 8, 16 and 35 mm in both 100 and 400 ft capacity.

462 SILICONE RUBBER COMPOUNDS

Acushnet Process Co.—Literature describes silicone rubber compounds and expanded services for the molding of precision parts now available from the company. Increased service temperatures to 500 F and for limited periods to 600 F are offered by five new compounds. Three compounds with low shrinkage characteristics in the 50 to 70 durometer range permit molding of parts and holding of close tolerance in existing tools.

463 LOCKING RING

Rosan, Inc.—Literature describes the firm's positive lock for steel inserts or studs in aluminum or magnesium alloys and other threaded fasteners and materials. No oversizes are required for replacements, the firm states.

464 AIR CLEANING EQUIPMENT

Green Fuel Economizer Co., Fan Div.—The company offers three bulletins covering: (1) Aerodyne industrial dust collectors; (2) Aerodyne packaged dust collectors; (3) Econ-o-Roll air filters.

465 ELECTRIC HEATING UNITS

Edwin L. Wiegand Co.—Catalog 60 covers specifications, construction details, application data, and prices of their complete line of electric heating units. Models are available with strip, ring, tubular, and cartridge heating elements. Also described are immersion, circulation, radiant, and forced-air duct heaters. Charts and tables are provided.

466 VIBRATION TEST MACHINES

All American Tool & Mfg. Co.—Catalog F describes five new models of vibration fatigue testing machines equipped with electronically controlled drive motors and automatic range selector for variable acceleration control. Units are said to provide infinite frequency control within the range of 5 to 100 cps, recorded on an electric tachometer.

467 FILTERS

Air-Maze Corp.—General catalog describes entire line of air filters and liquid filters, including oil bath air filters for engines, compressors, blowers, heating and ventilating filters and electrostatic precipitators, all metal, cleanable liquid strainers offering down to 10 micron filtration, odor eliminator panels, intake silencers, exhaust spark arresters.

468 BELT FEEDER

Omega Machine Co. Div., B-I-F Industries, Inc.—Design features of Model 37-20 belt type gravimetric feeder are covered in Bulletin 35-N62. Unit is designed to feed more than 3000 lb per min.

469 STEREOMICROSCOPES

Bausch & Lomb—A catalog discusses principles and equipment used in connection with stereomicroscopy. A guide to the selection of stereomicroscopes and accessories is included, along with reproductions of specimens seen through this medium. Catalog D-15.

470 STAINLESS STEELS

G. O. Carlson, Inc.—A four-page folder shows applications of stainless steel in plates, plate products, heads, rings, circles, forgings, flanges, bars, sheets. Products, equipment and services of the firm are discussed.

471 WORM GEAR JACKS

Duff-Norton Co.—Eight-page bulletin, No. AD-66, describes how two or more jacks can be tied together in a jacking arrangement by means of couplings, shafting, and mitre gears boxes. All jacks will raise and lower in unison and arrangements can be motor driven. Jack capacities range from two to one hundred tons. Specifications and dimensions drawings are included.

472 PACKINGS

Johns-Manville—A 12-page brochure, PK-17A, contains a packings selection chart of rod, plunger, and valve stem packings; illustrations and descriptions of precision rings, hydraulic and groove packings, oil seals, metallic and cut gaskets. Friction materials are also described.

473 REPRODUCTION MATERIALS

Eastman Kodak Co.—All materials available for reproduction of drawings and documents described in a booklet. A selection chart which matches originals to be reproduced with the recommended materials is included.

474 RESERVOIRS, STANDPIPES

Koven Fabricators, Inc.—Bulletin 555 describes and illustrates steel reservoirs and standpipes designed to provide water storage from 50,000 to 2,500,000 gal. Bulletin 501 covers stress relieving, X-ray inspection, hot dip galvanizing.

475 HONING EQUIPMENT

Micromatic Hone Corp.—A 32-page catalog, AR-136, explains Microhoning process, including stock removal and automatic size control. Applications, specifications, work capacities of machines for small, medium range diameters, long stroke vertical machines, horizontal machines, multiple-spindle machines are given. Also described are tools, job services, and other company aids.

476 STAINLESS, SPECIAL PURPOSE ALLOYS

Carpenter Steel Co.—A 12-page booklet contains information on selection, properties, corrosion resistance and workability of stainless steels. Also included is a description of alloys available for electronic, magnetic and electrical applications, and alloys for elevated temperature service.

477 POLYVINYL PRODUCTS

B. F. Goodrich Chemical Co.—A booklet gives properties and illustrates applications of Geon vinyl resins for industrial and consumer uses in extrusions, film and sheeting, molded products, expanded vinyls, coatings and rigid materials.

478 HEAT EXCHANGERS

Pfaudler Co. Div. of Pfaudler Permutit Inc.—Manual No. 949 illustrates and describes the firm's new standardized alloy designs of shell and tube equipment for application in the chemical and food industries. They may be used for: condensers, heat exchangers, heaters, evaporators, coolers, and reactors. Selection data, system diagrams, specifications, construction, installation.

479 RING-LOCKED FASTENERS

Rosan, Inc.—Literature describes the firm's locking ring principle for positive lock for steel inserts or studs in aluminum or magnesium alloys and other threaded fasteners and materials.

480 WORM GEAR REDUCERS

Jones Machinery Div., Hewitt-Robins, Inc.—A 40-page booklet contains description of various worm gear reducer designs with horsepower ranging from less than .1 to 121. Numerous drawings and specification tables show designs and ratings for standard units available.

481 TOOL STEELS

Crucible Steel Co. of America—A six-page index to Crucible tool steels and AISI type classifications. The cross index is an aid to making an accurate identification and selection of tool steels for specific jobs.

482 CLEANABLE FILTERS

Cuno Engineering Corp.—Literature covers Auto-Klean and Super Auto-Klean edge-type cleanable filters, and filters for built-in installations, and Micro-Screen filter elements of reinforced screen mesh.

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LATEST INDUSTRIAL LITERATURE

483 PIPE FABRICATION

Dravo Corp., Machinery Div.—Bulletin 1704 illustrates a part of the firm's record of engineering construction of pipeline pumping and compressor stations for the transmission and storage of gas and petroleum products.

484 ELECTRICAL CONTROL CABINETS

Industrial Equipment Co.—Brochure shows sizes and construction of metal cabinets for electrical and hydraulic control panels. Special types are also shown.

485 INDUSTRIAL COOLING FANS

Koppers Company, Inc., Metal Products Div.—A 4-page folder illustrates and describes new, all-metal, "Precision-Engineered" Aeromaster fans for cooling towers and radiator-type coolers. Design features are discussed.

486 GLASS INSULATION

Pittsburgh Corning Corp.—Six specifications cover application of the firm's Foamglas insulation for industrial equipment and piping. Each booklet contains tables of suggested thicknesses of insulation to be applied, detail drawings of installation procedure, insulation supports.

487 TECHNICAL BOOKS FOR ENGINEERS

Ronald Press—Brochures containing detailed descriptions of current technical books on mechanics, engineering, aeronautics, industrial management, metallurgy, applied and physical sciences, etc. Practical reference works like the Ronald Handbooks, basic studies, and pioneering works on the latest engineering and scientific developments are included.

488 FIXED TYPE GAGES

Sheffield Corp.—Catalog LTG-54, 148 pages, is composed of six sections covering the company's standard fixed type gages. A complete engineering manual for gage designers and users is included in the catalog.

489 DROP FORGED COUPLINGS

Bonney Forge & Tool Wks.—New drop forged flats described in this bulletin are half couplings beveled for convenience, tapered for strength and ruggedness. In larger sizes, the flat Weldolet is designed to provide an integrally reinforced nozzle for vessel heads and caps.

490 MECHANICAL-OPTICAL FACILITIES

Kollmorgen Optical Corp.—Bulletin 500 describes facilities for precision mechanical and optical manufacturing. It includes engineering and inspection equipment, plus narrative outlining company's activities in the fields of atomic energy, nuclear research and remote observation, with emphasis on industrial periscopes of which it is a prime supplier for government and commercial use.

491 CORRUGATED ROOFING, SIDING

Philip Carey Mfg. Co.—Form 6300 illustrates corrugated asbestos-cement roofing and siding composed of Portland cement and asbestos fibres combined under pressure to form a homogeneous, monolithic sheet. The material is highly resistant to fire, acid and alkali fumes, salt air, rot proof and rodent proof. It never needs painting, but can be painted. Because deep corrugations provide beautiful shadow effects, it is often used for decorative purposes.

492 O-RINGS

National Seal Div., Federal-Mogul-Bower Bearings, Inc.—This National O-ring catalog is designed for broadest usefulness in all types of O-ring applications. Includes practical working information about O-ring applications, sizes, groove dimensions, back-up rings, and dust seals, and lists all National O-rings and local National Seal Division offices.

493 HYDRAULIC MULTIPRESS

Denison Engrg. Div., American Brake Shoe Co.—Catalog 120-D illustrates and describes the firm's hydraulic multipress in 10 sizes from 1 to 75 tons capacity. General specifications and diagrams are included for the various models and accessories.

494 OIL-RETAINING BEARINGS

Bound Brook Oil-Less Bearing Co.—More than 600 of the most widely used sizes of oil-retaining porous bronze bearings are listed in the firm's Stock List No. 4. Also provided is condensed information on application, installation, lubrication and machining.

495 REFRIGERATING MACHINE

American Blower Div., American-Standard—Bulletin 1426, a catalog describing the Tonrac single-stage hermetic centrifugal refrigerating machine, shows in cutaway construction details, including condenser, single-stage compressor, marine type water boxes, evaporator, tube bundle, float valve, lubrication system, motor and purge system.

496 ALLOY STEELS

Copperweld Steel Co.—A 16-page bulletin covers lead treated steels. Case histories of components made of the material are included, along with data on characteristics and mechanical properties of various leaded alloys.

497 SUPER REFRACTORIES

Carborundum Co., Refractories Div.—"Properties of Super Refractories," twenty-four pages, covers latest data on super refractories including newly developed compositions for specialized applications. Re-frax silicon-nitride bonded silicon carbide refractories which can be produced in intricately designed shapes to close dimensional tolerances is described. Chemical analysis and physical property charts are provided on all materials.

498 TECHNICAL BOOKS AND PAPERS

The American Society of Mechanical Engineers—A 20-page catalog describing current books, standards, codes, research reports and periodicals published by the Society and a listing of available technical papers.

499 TUBE EXPANDERS

Gustav Wiedeke Co.—Catalog 81 contains specifications on the firm's line of tube expanders and cutters. Included are tables of sizes, ordering information and a list of domestic and foreign distributor locations.

500 FILTERS, FILTER ELEMENTS

Cuno Engineering Corp.—Catalogs cover Micro-Klean replaceable filter elements, Flo-Klean automatic self-cleaning wire-wound filters, Poro-Klean porous stainless steel media for filtration, Micro-Klean filters for air line service, and Micro-Screen filter elements of reinforced screen mesh.

501 STAINLESS STEEL HOSE

Allied Metal Hose Co.—A four-page folder, SSDS-562, illustrates and describes stainless steel hose which is flexible and able to handle safely pressures to 4000 psi at temperatures through 1500 F. The hose is used to absorb vibration, correct misalignment and offset motion, as chemical loading hose, for weight tank connections and as an expansion compensator.

502 RESEARCH FACILITIES

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin D-1005 illustrates and describes the firm's expanded and improved test and research center for basic equipment, for Portland cement, lime, asbestos, phosphate, light-weight aggregate.

503 CHEMICAL ENGINEERING

Burns and Roe, Inc. A six-page folder describing the firm's services to the chemical industry. These include process, equipment, and building design; preparation of drawings and specifications; and supervision of construction. Folder describes engineering of plants and equipment for uranium and beryl ore processing, ultra-pure silicon production, and chemical support and water treating facilities.

504 HYDRAULIC CAR SHAKER

Stephens-Adamson Mfg. Co., Engineering Div.—Bulletin 658 presents comprehensive technical data, drawings, and illustrations of the Carquake, hydraulically powered car shaker.

505 ALUMINUM PIPE, FITTINGS

Aluminum Co. of America—A 20-page booklet covers process piping, pipelines, portable piping, structural piping applications, fittings and flanges, installation, dimensions and weights of aluminum pipe and fittings. Form 10197.

506 REFRACTORY BRICK

Norton Co.—A 24-page booklet covers refractory brick and other fired shapes. Materials available, methods of manufacture, properties and characteristics, tables, graphs, and conversion charts are included.

507 ULTRASONIC CLEANING

Branson Ultrasonic Corp.—Bulletin S-200, 24 pages, explains principles and applications of cleaning with high-frequency sound waves. Equipment design and description of Sonogen generators and transducers are included. Batch, conveyor, and multi-stage systems for cleanliness at production rates are covered.

508 GAGING APPLICATIONS

Sheffield Corp.—A 12-page booklet shows how column type Precisionaire gages are used to inspect single and multiple, internal and external dimensions and other geometrical conditions and relations.

509 VIBRATING HEATERS, DRYERS

Carrier Conveyor Corp.—Technical information is given on natural frequency vibrating heaters, dryers, and coolers. Heat transfer units both in horizontal and spiral elevator designs are listed. Drying and cooling can be accomplished on the same unit and simultaneously with the conveying or elevating of the material.

510 QUICK OPENING DOORS

Struthers Wells Corp.—Bulletin SW-553 covers quick opening doors for processing equipment. Automatic or semi-automatic in operation, the units are available in Ring-lok or Wedg-lok types, designed for vulcanizers, devulcanizers, impregnators, sterilizers, cement block curing vessels, ovens, and creosoting cylinders.

511 THERMOCOUPLE REFERENCE JUNCTION

Pace Engineering Co.—Data sheets describe a precision and a utility series of Thermocouple Reference Junctions of multi-channel temperature measurement systems. A discussion of special circuit features and Thermocouple combinations is included, as well as specification on temperature stability and uniformity among channels.

512 COMPRESSED AIR UNITS

Hankison Corp.—A 20-page catalog describes construction, operation and performance of compressed air units, combination condenserfilter for instrument air, dehydrofilter for vapor-free air lines, condensate discharge trap.

513 SELECTIVE PLATING

Dalic Metachemical Ltd.—Selective plating for engineering purposes is covered in a booklet that explains the process, analyzes the metallurgical properties of the deposits, and covers engineering applications. Included are touching up, resizing mismachined components, precision fitting of bearings, plating assembled electrical contacts, selective stopping-off before heat-treating, printed circuits, depositing extremely pure metals, automatic wire and strip plating.

514 WELDING ALUMINUM

Aluminum Co. of America—A 176-page hard cover book gives basic, practical data on the various processes for welding aluminum with special emphasis on the inert gas methods. Included is guidance in selecting the process and the alloy. One chapter is devoted to the performance of welds. Illustrated, 32 tables. Form 10415.

515 SECTIONAL CONVEYOR

Stephens-Adamson Mfg. Co., Standard Products Div.—Bulletin 458 lists comprehensive technical data, preengineered features and an exploded illustration of the firm's new sectional belt conveyor.

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LATEST INDUSTRIAL LITERATURE

516 STRUCTURAL PANEL

Philip Carey Mfg. Co.—A folder, Form No. 6293 describes a 2-in-1 insulated structural panel for interior use in duct construction, industrial ovens, coil housings, plenum chambers. It is formed of laminated plies of corrugated and flat asbestos paper sheets, bonded with a fire-resistant adhesive suitable for continuous temperature up to 1000 F.

517 STORAGE TANKS

W. E. Caldwell Co.—A 48-page catalog, No. 65, contains technical data, illustrations and price information covering metal and wood tanks with mechanical equipment and other accessories. Included are elevated and ground storage tanks, field erected, shop build pressure, vented tanks.

518 QUALITY CONTROL

Burns and Roe, Inc.—A four-page bulletin describing firm's quality control services covers such engineering functions as the design of quality control systems, inspection of facilities and purchased supplies at the vendor's plant, inspection and testing at the job site of equipment, materials and systems, and the handling of special problems.

519 FORCED, INDUCED DRAFT FANS

Green Fuel Economizer Co., Fan Div.—The company offers bulletins covering: (1) mechanical draft fans; (2) airfoil type fans; (3) fly ash collectors; (4) economizers.

520 GLASSED STEEL

Pfaudler Co., Div. of Pfaudler Permutit Inc.—Bulletin 928 illustrates and describes the corrosion resistance of glassed steel to acid solutions. Resistance charts of various nitric, acetic, sulphuric, hydrochloric and phosphoric acid solutions are included in the booklet.

521 TIME ORGANIZER

Kano Laboratories—Literature describes a time organizer system in which items are listed on numbered lines and checked out as completed. The system includes a three-year calendar, annual and monthly check charts.

522 PRECISION MEASUREMENT

Sheffield Corp.—A 22-page brochure describes the precision measurement and inspection services of the firm's Eli Whitney metrology laboratory. Services include calibration and certification of gage blocks, roundness determination, hardness testing, surface finish analysis, thread and plug gage calibration.

523 REFUSE INCINERATOR WALLS

Bernitz Furnace Appliance Co.—Bulletin B-58 describes silicon carbide air-cooled blocks for incinerator walls. The blocks are designed to improve combustion, insure long furnace wall life, and reduce maintenance and down time.

524 BELT CONVEYORS

Jeffrey Mfg. Co.—Bulletin 909 on belt conveyors gives information on applications and selection. Tables on terminal selection are included, along with engineering data on idler spacing, slopes, curves, drives, speeds, and loading.

525 CARBON SPECIALTIES

Morganite, Inc.—A 12-page bulletin illustrates, describes and gives design data on carbon specialties in such applications as self-lubricating bearings, valves, slides, seal noses, gland rings, piston rings and vanes.

526 AUDITORIUM AIR CONDITIONERS

John J. Nesbitt, Inc.—Catalog 22 illustrates and describes AudiCon air conditioner, designed especially for school auditoriums and other large assembly areas where quietness is important. Unit features silencer discharge plenum, plus return air bypass control.

527 HYDRAULIC FLUID

Shell Oil Corp.—A technical bulletin covers Irus fluid 902, a fire-resistant fluid for hydraulic applications. Information is given on safety and tests, operating advantages of the fluid, preparation and maintenance of hydraulic systems.

528 URETHANE FOAMS

Allied Chemical Corp.—Technical Data Bulletin 71558, available from National Aniline Div., gives physical properties, formulations and production methods for polyester rigid urethane foams based on Nacconate 1080-H. Pouring, spraying, foaming-in-place, sandwich construction, and curing process are described.

529 CURVE CROWN PULLEY

Stephens-Adamson Mfg. Co., Standard Products Div.—Bulletin 558 illustrates and describes the firm's new curve crown pulleys. The literature features technical and engineering data, specifications on the new welded, all steel pulley.

530 ALUMINUM HANDBOOK

Aluminum Co. of America—A hard cover book contains data on aluminum alloys and mill products in tabular form. Information is given as reference for those responsible for planning, designing, testing, purchasing, and fabricating aluminum successfully. Form 10051.

531 ROTARY CAR DUMPER

Heyl & Patterson Inc.—Literature describes a new rotary railroad car dumper. The unit is equipped with two clamps holding the car securely, not requiring counterweights. It can be dumped and returned in one minute with a 30-hp drive. Optional equipment is electronic scale in the dumper platen and power operated car retarders.

532 CLAD STEEL EQUIPMENT

L. O. Koven & Bro., Inc.—A booklet gives data on the development of properties, types, testing, design considerations, fabrication, and applications of clad steels. Another booklet covers the cleaning and maintenance of clad steel equipment.

533 BAG FLATTENER

Carrier Conveyor Corp.—Literature describes the firm's natural frequency bag flattener. Bottom heavy bags from the filling machine are dropped onto the flattener with the unfilled end of the bag in front. The material inside the bag conveys faster than the bag itself so that the material fills up the forward end of the bag. Bags of very fine material, such as cement plaster and diatomaceous can be conveyed between the trough which vibrates in a 1-in. stroke and an impactor plate to squeeze out excessive air.

534 NICKEL, ALLOYS

International Nickel Co.—A 28-page booklet covers a unique, new cast metal that combines such properties as strength and toughness with resistance to heat, wear, and corrosion. Tables and graphs explain mechanical and physical properties, erosion and corrosion resistance, high temperature strength. A special section points out industrial applications of Ni-Resist ductile iron.

535 TECHNICAL PUBLICATION SERVICES

Burns and Roe, Inc.—A six-page brochure describes services of a department specifically organized to handle technical writing, editing, layout, illustration, editorial production, printing supervision, reproduction, and fine printing. Examples from several manuals, handbooks, booklets, slides, graphs, and other material.

536 SUCCINIC ANHYDRIDE

Allied Chemical Corp.—Technical Bulletin I-11, available from National Aniline Div., gives chemical reactions and properties, suggested uses, and physiological properties of succinic anhydride.

537 FANS, BLOWERS

Robinson Ventilating Co.—Bulletin 502 illustrates and describes fans, blowers, exhausters. Application photos are included, along with data on air properties, pressure and velocities.

Read the various items listed . . . one catalog may hold the solution to your present problem . . .

538 ALUMINUM CASTINGS

Morris Bean & Co.—Booklet on the Antioch Process offers a brief description of the process used currently in the production of aluminum castings weighing up to 2000 lb and up to 10 ft in diameter. Loose specification sheets covering applications in aircraft, missile, electronic, and fluid flow fields are available.

539 PLANT CONSTRUCTION

Nooter Corp.—Brochure describes, by example, the firm's field construction department for fabricating and erecting processing equipment for such industries as chemical, petroleum, brewing, food, pharmaceutical, and public utilities.

540 SHEET METAL FASTENERS

Rosan, Inc.—Literature covers a press-nut sheet metal fastener that locks both axially and radially and will develop full strength of mating bolt in most materials. It is available in stainless steel or Ledloy material; internal thread sizes are No. 2 through $^1/_4$, with or without internal thread locking features.

541 SILVER BRAZING OUTLETS

Bonney Forge & Tool Wks.—Brazolets used for silver brazing outlets to copper or brass pipe or tubing are described in this bulletin. The outlet portion is brazed or screwed. This construction is said to allow rapid installation of random length mains and subsequent attachment of outlets.

542 CUSTOM MOLDING TEFLON

Sparta Mfg. Co.—A four-page brochure covers patented process of custom molding parts of Teflon in thin sections and shapes. Properties and characteristics of Teflon, suggested end uses, and illustrations of such parts designed through the process as cup, ball, or shaft seals, washers, gaskets and diaphragms are included.

543 FIRE-RESISTANT FLUIDS

Shell Oil Co.—A technical bulletin gives detailed information on synthetic fire-resistant hydraulic fluids. Data covers applications, operating advantages, procedures for changing systems and packings, gaskets, paints, and seals.

544 HAND FORGINGS

Aluminum Co. of America—A booklet answers questions on high-strength, low-weight advantages of aluminum for parts of limited production. The booklet presents detailed discussions of factors that influence the production of quality hand forging. Form 10595.

545 THERMOCOUPLE SYSTEM CALIBRATOR

Pace Engineering Co.—A manual gives the theory and operation of equipment for calibrating multichannel thermocouple recording systems. The calibrator is one in which the reference temperature and scale are established by injection of monitored voltages supplied by two mercury cells.

546 TECHNICAL BOOKS

Lefax Publishers—A revised catalog covers pocket size technical data books. The books cover every field of engineering, including aeronautics, air-conditioning, automotive engineering, diesel engineering, home heating, machine design, machinists' data, mechanical drawing, mechanics of materials, metals, piping data, power transmission machinery, steam engineering, thermodynamics tables and charts, general mathematics, five-place trig. and log. tables, heterogeneous mathematics tables.

547 ULTRASONIC GAGING

Branson Instruments, Inc.—Technical Bulletin V-200 covers ultrasonic gaging used to measure metal or plastic thickness from one side, to determine corrosion rates, and detect laminar discontinuities, flaws. Included is a description of a newly developed automation converter used in automatic sorting, high and low-limit alarms, automatic acceptance and rejection, and other methods of automatic control.

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GUIDE

548 THERMOCOUPLE TABLES

Pace Engineering Co.—A series of tables are available for use with heated type of thermocouple reference junction in industrial and laboratory installations. A 150 F reference temperature is used. Copper, chromel, iron types covered.

549 COOLANT EQUIPMENT

Bijur Lubricating Co.—Literature describes Spraymist coolant equipment. Air filter, trap, regulator, gage, solenoid-valve conduit box, pressurized coolant reservoir and filter are included with the equipment.

550 TOOL STEELS

Crucible Steel Co. of America—Forty-six pages of information concerning tool steels for forging operation, the die casting process and the hot extrusion process. A series of charts detail the tool steel and heat treatments recommended for numerous forging, die casting, and extrusion operations. Also included is a brief trouble shooting guide.

551 HARD CARBIDES

Kennametal, Inc.—A 44-page booklet describes basic design principles for use of hard carbides; methods of forming; methods of fastening carbides mechanically; and a general treatise of Kennametal and suggested fields of application.

552 CONDENSERS, COOLERS

Niagara Blower Co.—Three bulletins are offered. No. 130 covers methods for cooling compresses air or gas consistently to below ambient temperatures; No. 131 shows benefits of panel construction in condensers with unit capacities of 100 to 240 tons refrigeration; No. 132 describes a self-contained, evaporative method of cooling liquids in a closed system.

553 ULTRASONIC MACHINING

Sheffield Corp.—How to use ultrasonic energy to cut, drill, emboss, engrave, slice, and dice hard and brittle metals and nonmetals is shown in publication No. CAV 7-56. The 16-page illustrated booklet describes the ultrasonic machining process, shows examples of designs and forms machined in carbide, glass, germanium, ferrite and ceramic, and also includes specifications and machining capacities of ultrasonic machine tools.

554 SPRING MATERIALS

Hunter Spring Co.—A 12-page booklet discusses pricing, quoting, tolerances, tangling, packaging, spring materials with cost comparisons, quality reporting.

555 BEARING CUPS, CONES

Timken Roller Bearing Co.—An illustrated brochure tells how the company's continuous high-speed production methods at its Bucyrus, Ohio plant is holding down bearing costs and explains how manufacturers can benefit from these economies. Includes price index history demonstrating what these economies mean to the automotive industry. Back cover chart shows the 30 bearing cups and cones in the Green Light series which covers bore sizes from .7500 to 2.625 in.

556 LIQUID LEVEL CONTROLLER

Leslie Co.—Bulletin 583 covers the firm's Level-Matic liquid level control pilot. Characteristics, design advantages, and installation facts, and how its simplicity and adjustable proportional band eliminate problems associated with other methods are included.

557 MATERIALS HANDLING

Conveyor Systems, Inc.—Catalog No. 6 consists of 90 pages of data relative to conveyors and special materials handling equipment for use in all industries.

558 SELF-LUBRICATING BEARINGS

Lubrite Div., Merriman Bros., Inc.—Manual No. 55-2 contains information, technical data and specifications about self-lubricating bearings and expansion plates for bridges, buildings, refinery, and chemical processing equipment and other structural uses. Also available manual on self-lubricating bearings for equipment, machinery, hydro-electro type applications.

559 FLEXIBLE METAL HOSE, TUBING

Allied Metal Hose Co.—Data Sheet SSDS-562 gives engineering information and tabular data on stainless steel hose. Pressure capabilities, flexibility, suggested usage, formulas for determining best lengths are included. Threaded and flanged end fitting connections are diagrammed.

560 CRANE CONTROL

Clark Controller Co.—Bulletin 9100 is a manual and catalog on the selection and application of d-c crane control equipment. It explains basic hoist circuit, bridge and trolley motions, and components which make up crane control systems. Specifications and other details of control systems and components are included.

561 WELDING FITTINGS, FLANGES

Babcock & Wilcox Co., Tubular Products Div. Dept.—Welding Fittings Bulletins 252 through 275 is a series of 24 data folders cataloging by pipe size, dimensional and physical data of seamless welding fittings and forged steel flanges. Included in each is a description of various types and the pressure class of each type. The information covers the carbon, alloy, and stainless steels in which fittings and flanges are available.

562 OILLESS BEARINGS

Graphite Metallizing Corp.—Catalog 4 illustrates and describes solid and split self-aligning pillow blocks and hanger bushing assemblies with Graphalloy oilless bushings. They are designed to operate dry to 750 F in air in dryers, ovens, kilns, refuse burners.

563 COMPRESSION PACKINGS

E. F. Houghton & Co.—A catalog describes a new, simplified line of rod and sheet packings. The firm manufacturers hydraulic and pneumatic packings of rubber, Teflon, and leather.

564 SINTERED BEARINGS

U. S. Graphite Co.—Bulletin No. 18 describes design requirements, metallurgical requirements and alloy selection, plus general facts about Gramix sintered bearings. Design advantages, alloy selection and metallurgical requirements of the powdered metal machine parts are contained in Bulletin No. 19.

565 ELBOWS, FITTINGS

Midwest Piping Co.—A 20-page bulletin, No. 5801, points out benefits from a unique method of manufacture employed in making elbows. Among these benefits are: greater strength than seamless pipe, exceptional dimensional accuracy and uniformity, greater variety of fittings including difficult specials.

566 HOT WATER CONVERTERS

Patterson-Kelley Co.—Bulletin 303-A contains construction and operating data for hot water heating convertors. Tables show how to select proper convertors for such applications as industrial and domestic water heating.

567 MISSILE LAUNCHING EQUIPMENT

Loewy-Hydropress Div. Baldwin-Lima-Hamilton—Bulletin 14.004-B shows a revised and supplemented collection of the firm's activities in the field of missile ground handling and launching equipment, including the ship motion simulator for the Navy's ballistic missile program.

568 OIL FREE COMPRESSORS

Ingersoll-Rand—Form 1552 lists three models of Type-30 oil-free air compressors with nonlubricated cylinders: the Model N, the 23 ANL and the 235 HNL. They are designed for instrument control or applications where oil in the discharge air can't be tolerated. The units, which cover a 1/2 to 3 hp range, use carbon piston rings, making oil lubrication unnecessary in the cylinders.

569 STORAGE WATER HEATERS

Patterson-Kelley Co.—Catalog 19 gives capacities and weights, dimensions, conversion tables, fixture capacities, material thicknesses, heating elements and construction details of storage hot water heaters.

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570 MAGNET DRUM SEPARATOR

Stearns Magnetic Products—Bulletin 1051 covers the Indox V drum separator for continuous and automatic removal of tramp iron in process industries. The bulletin explains how the ceramic magnet material produces a uniform magnetic field up to 40 per cent more powerful than in ordinary permanent magnet units.

571 PROCESSING EQUIPMENT

Patterson-Kelley Co.—Bulletin 16 contains product description and specifications on the firm's line of blenders, vacuum tumble dryers, packaged resin-distillation pilot plants, and process heat exchangers. The bulletin also describes the organization and operation of the company's Pre-Test laboratory which, in testing customer formulations, helps determine proper blending equipment and correct blending procedures.

572 HYDRAULIC MACHINERY

Loewy-Hydropress Div. Baldwin-Lima-Hamilton—Bulletin 14,002 is a comprehensive catalog on hydraulic presses for extrusion, forging, die-forging, deep-drawing, Marforming, bending, up-setting and other metal forming operations. It also describes hydraulic stretch-straightening-detwisting machines, stretch-straightening machines for plate and sheet, and pipe testing and expanding machines.

573 BLAST CLEANING UNITS

Pangborn Corp.—Bulletin 705 describes new airless blast cleaning equipment. Features and dimensions of the new barrels, ranging from 20 to 102 cu ft capacities, are available for all heavy duty and production cleaning requirements. The Rotoblast wheel, throwing up to 60,000 lb of abrasive per hour the abrasive reconditioning system, and other features are covered.

574 PETROLEUM PRODUCTS PUMPS

Ingersoll-Rand—Form 70021 describes the new "Vapor-flo" motorpumps and the standard motorpumps for handling gasoline and fuel oil. The "Vapor-flo" has a special impeller that creates a vacuum to collect air or gas that may enter with fluid. Both types are for flooded suction and available in $^1/_3$ to 75 hp sizes and handle 5 to 3200 gpm.

575 HEATERS, HEAT EXCHANGERS

Patterson-Kelley Co.—Catalog No. 202 contains 36 pages of product data and application tables for instantaneous hot water heaters and heat exchangers. Data includes dimensions, standard connections, piping arrangements, and diagrammed line drawings of two-, four-, and six-pass instantaneous heaters, plus condensate coolers (or preheaters) and booster heaters constructed in accordance with ASME code requirements.

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MB Type 1812D83 mounts protect engines in shipping cans. Even for a 3-ft. drop, they restrain displacement and maximum "g" to which engine could be subjected. They also provide a natural frequency to the mass that avoids resonance and amplified vibration in transit.

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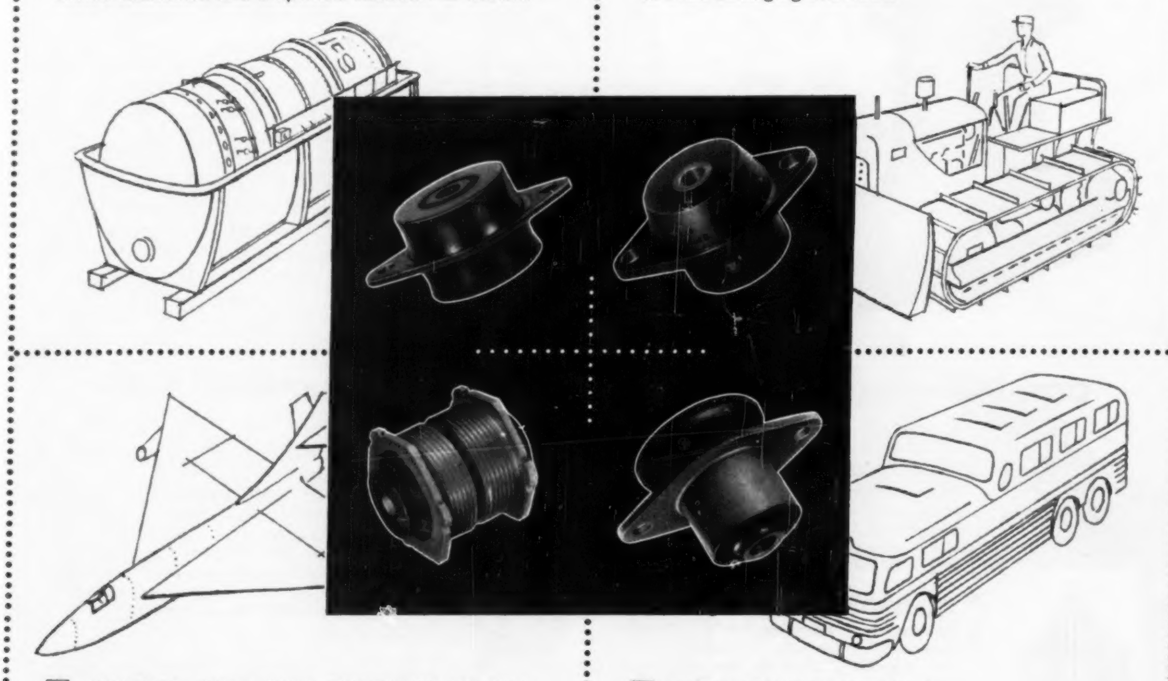
MB Type 5 mounts stand up and successfully isolate engines of even tractor dozers. The tough service conditions prove the efficiency of this original mount designed with equal spring rate in all directions, and with ability to snub damaging overloads.



☐ **CONTROL OVER FULL FREQUENCY RANGE**

MB ISO-DAMP* mounts do what a conventional isolator cannot. They isolate at both low and high frequencies. Protecting the precision of airborne sighting mechanisms, they not only have the required softness, but also a damping mechanism that restricts resonant build-up to under 3.5 to 1 in any direction.

*T.M.

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MB ISOMODE® mounts break endurance records. Despite heat, road shock and hard operating conditions in bus service, engine mounts removed for critical inspection after 132,000 miles were still good. To such durability add the superior vibration isolation afforded by a mount that controls vibratory motion in all directions.

MB concentrates on standard mounts which are actually in the special performance class. If you have a problem, avail yourself of our 20 years of experience. Send for Bulletin 616A which tells more.

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Featuring Walworth Pressure-Seal Valves

Here are cast steel valves built for high-pressure, high-temperature service. The unique bonnet-to-body design utilizes internal line pressure for a tight, leakproof connection. The higher the pressure the tighter the bonnet joint! Bulky, heavy bonnet flanges, bonnet studs, and nuts are completely eliminated providing a modern valve design of truly streamlined proportions. Maintenance is simplified as Walworth Pressure-Seal Valves are easily assembled, disassembled, and insulated.

Walworth Pressure-Seal Valves are available in 600, 900, 1500 and 2500 Lb ratings, ASA B16.5 – 1957, and in a wide range of sizes and types. Complete information is available from your nearby Walworth Distributor – or – write Walworth for a free copy of Circular 16.

and including these valves for "'round-the-plant" use!

WALWORTH SMALL CAST STEEL Y-GLOBE VALVES. Simplified design eliminates many of the problems encountered in high-temperature, high-pressure service. No bonnet joint. Improved back-seat design means longer life for packing rings.

WALWORTH LUBRICATED PLUG VALUES. Easy turning—quick operating. Lubricant can be renewed while the valve is in service. Lubricant completely surrounds the plug ports for a tight seal against leaks. Remember, always use Walworth Lubricant in Walworth Lubricated Plug Valves.

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WALWORTH IRON BODY GATE VALVES. Straight-flow port design reduces fluid turbulence to a practical minimum. Seat rings of end-seated type are screwed into the body. Brass liner on glands assures greater resistance to corrosion and scoring. Available with threaded or flanged ends.

WALWORTH CAST STEEL GATE VALVES. Bolted bonnet, wedge gate, OS&Y. Bonnets and bodies are engineered to withstand pressure and minimize distortion. Heavy steel walls provide extra strength and longer life. Deep stuffing boxes in all sizes (2" to 24") insure tightness and maximum packing life. Also available in globe and angle types.

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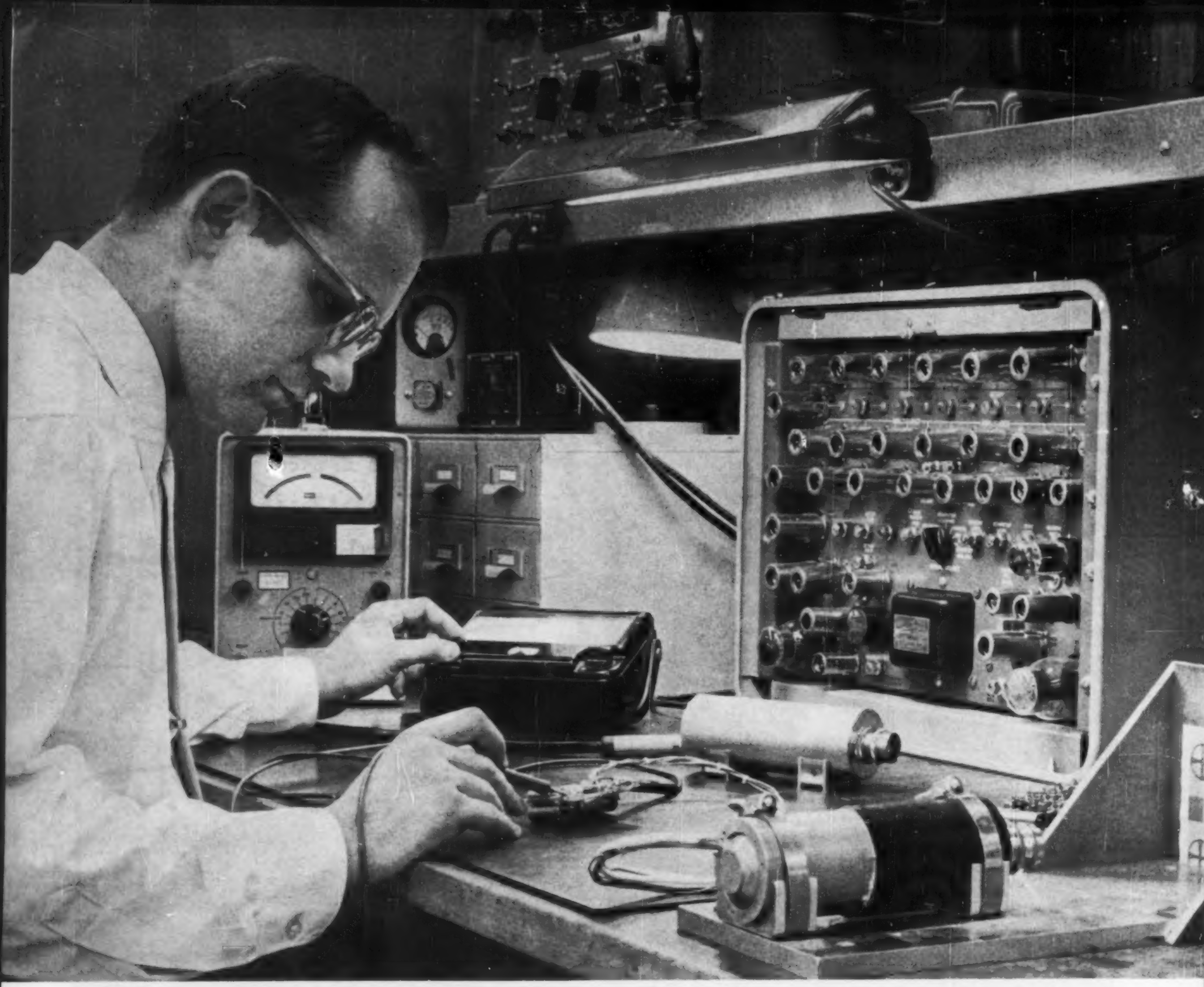
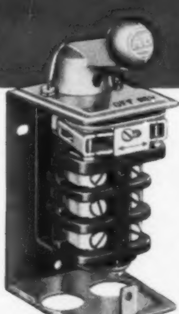


ALLEN-BRADLEY ANNOUNCES

NEW BULLETIN 350 reversing drum switch



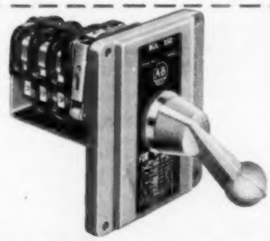
Bulletin 350 with wrap-around cover removed to show accessible contacts. Max. rating: 2 hp.

- *CHANGEOVER A MATTER OF SECONDS* —to momentary or maintained contacts.
- *COMPACT.* Switch fits into small space—easily accessible mounting holes.
- *EASIER WIRING* with front mounted terminals and wrap-around cover.
- *NO SPACERS.* Back or base of switch mounts directly on machine surfaces.

Note the clean, modern lines of this new switch . . . it was styled by Brooks Stevens, internationally known industrial designer. But its beauty is more than skin deep. Inside its enclosure is a rugged switch, designed for easier installation and long, trouble free life.

The compact, low cost Bulletin 350 reversing switch is equivalent to a three-pole, double throw switch . . . and can be used with a.c. or d.c. motors. The switch mechanism is a self-contained unit—independent of the enclosure—thus eliminating any possibility of misalignment.

All Allen-Bradley distributors . . . your "Motor Control Headquarters" . . . have a stock of these new Bulletin 350 drum switches on hand. Order them today.



OILTIGHT CAVITY MOUNTING

The new reversing switch can be furnished with a rubber gasketed oiltight cover plate for cavity mounting in a machine base.

A-B QUALITY

ALLEN-BRADLEY

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MOTOR CONTROL

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POWELL

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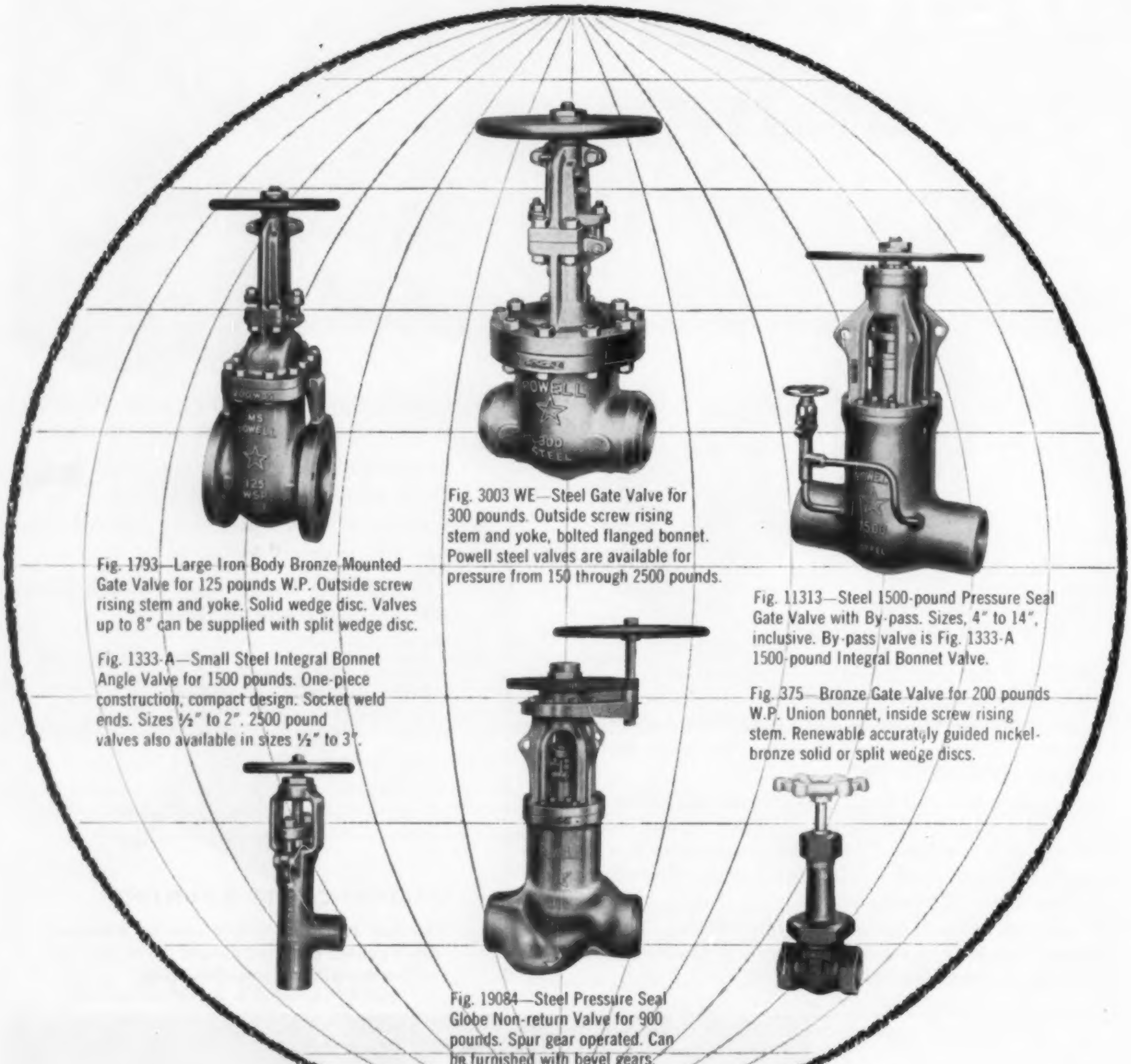

Fig. 1793—Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.P. Outside screw rising stem and yoke. Solid wedge disc. Valves up to 8" can be supplied with split wedge disc.

Fig. 1333-A—Small Steel Integral Bonnet Angle Valve for 1500 pounds. One-piece construction, compact design. Socket weld ends. Sizes ½" to 2". 2500 pound valves also available in sizes ½" to 3".

Fig. 3003 WE—Steel Gate Valve for 300 pounds. Outside screw rising stem and yoke, bolted flanged bonnet. Powell steel valves are available for pressure from 150 through 2500 pounds.

Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 pounds. Spur gear operated. Can be furnished with bevel gears.

Fig. 11313—Steel 1500-pound Pressure Seal Gate Valve with By-pass. Sizes, 4" to 14", inclusive. By-pass valve is Fig. 1333-A 1500-pound Integral Bonnet Valve.

Fig. 375—Bronze Gate Valve for 200 pounds W.P. Union bonnet, inside screw rising stem. Renewable accurately guided nickel-bronze solid or split wedge discs.

A solution for every kind of flow control problem is as near as your local Powell distributor. Powell valves are designed and engineered in the largest variety of metals and alloys, to handle any medium, every flow control requirement. There are Powell distributors in all principal cities. Or, if yours is a special engineering problem, write to:

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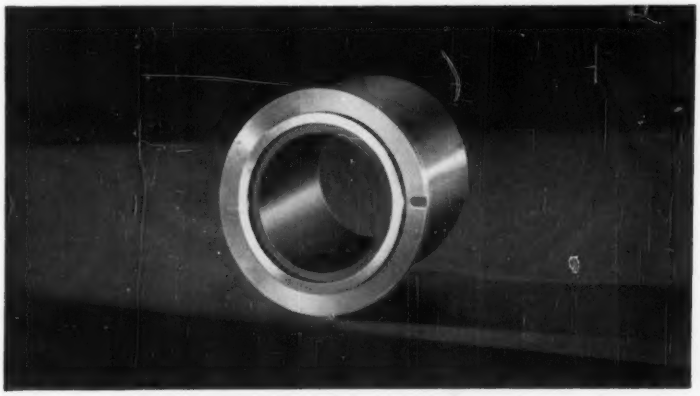
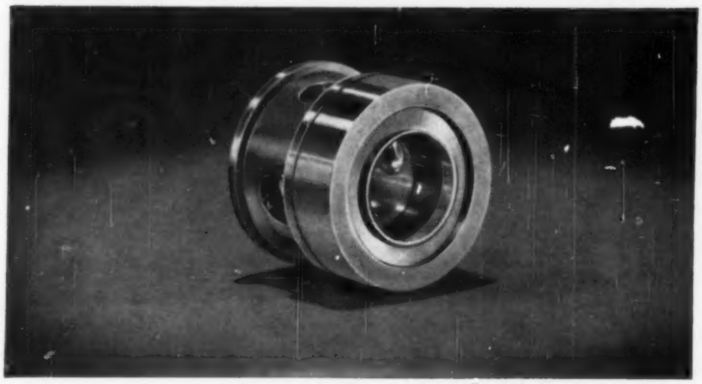
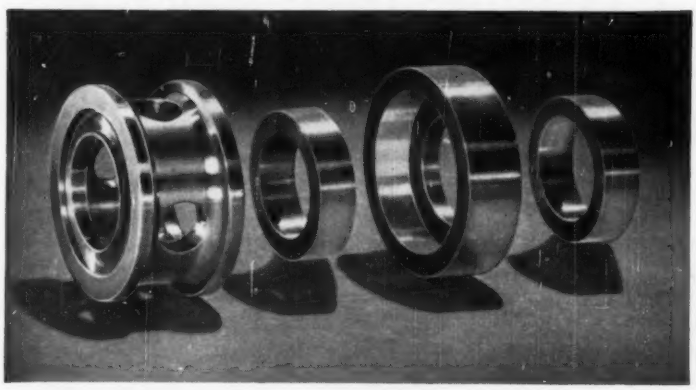


SINGLE BUSHING TYPE Floating Ring Seal

Seal Any Medium—Even Corrosive Media ... with Koppers Floating Ring Seal



MULTIPLE RING TYPE Floating Ring Seal (assembled)



FLOATING RING SEAL Basic Elements: Lantern Ring, Floating Ring, and Spacer Diaphragm. As sealing needs dictate, floating rings and spacer diaphragms are added. Seals are carbon, plastics, ceramics or steel, as applications require.

The Only "No Maintenance" Seal for Rotating, Oscillating and Reciprocating Motion

Koppers' precise, efficient Floating Ring Seal assures long seal life, low leakage, reduced wear, less power consumption, and decreased operating costs.

It seals at high temperatures and at pressures up to, and for some conditions even above, 2000 psi. Inspection has shown that after 10,000 hours of operation, ring and spindle wear can be negligible. For water at 500° F. and 1200 psig with a ⅝" spindle, leakage is only one to two pounds per hour. Frictional power requirements are virtually zero, and Koppers' design reduces radial frictional restraint. Sealing members adapt to changes in the shaft's position.

Applicable to valve spindles, pumps, atomic reactor spindles and many other similar installations, Koppers Floating Ring Seal gives efficient, low-cost service for the sealing of all types of fluids under widely varying conditions of temperature and pressure.

For additional information, write to: KOPPERS COMPANY, INC., Piston Ring and Seal Department, 9311 Hamburg Street, Baltimore 3, Maryland.

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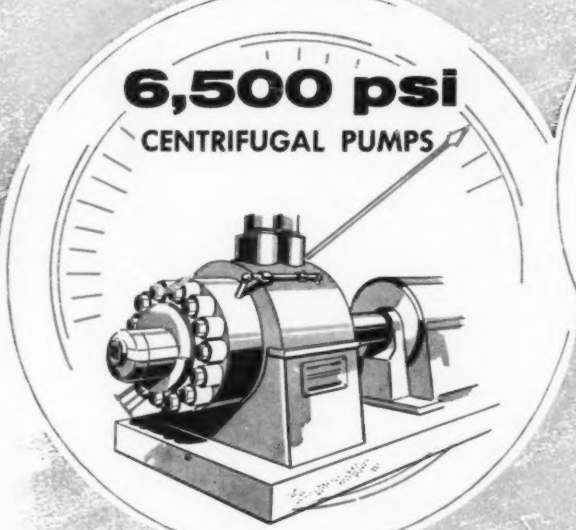
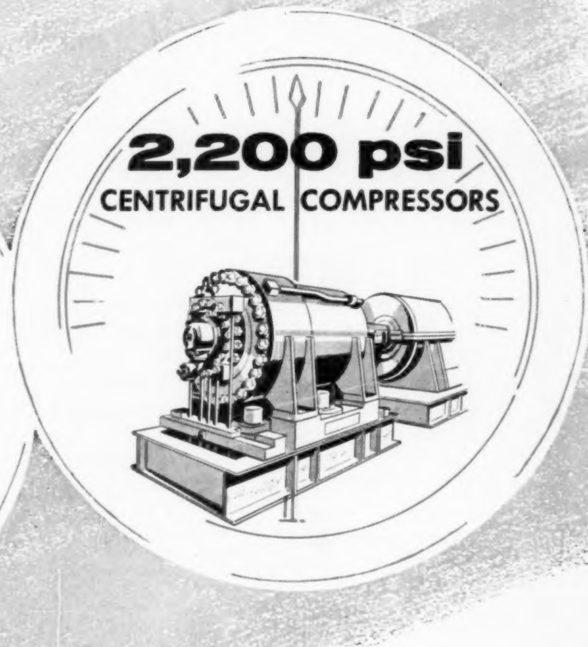
Engineered Products sold with *Service*

hi-psi *





These gauges show high levels of gas and liquid pressures created by machines designed and built by Ingersoll-Rand.

Such pressures have not always been practical. Most top levels have crept up little by little as new processes in industry demanded higher and still higher pressures. Those indicated here are bold advances, much higher than the preceding highs. Each is another building block in the foundation of experience.

Through a half century of such experience Ingersoll-Rand has been closely associated with the process and petrochemical industries. If you need to compress a gas, or pump a liquid at any pressure you choose to call high, take advantage of Ingersoll-Rand's experience that has continuously set the pace in high-pressures.

* **hi-psi** . . . high pressures, measured in pounds per square inch.

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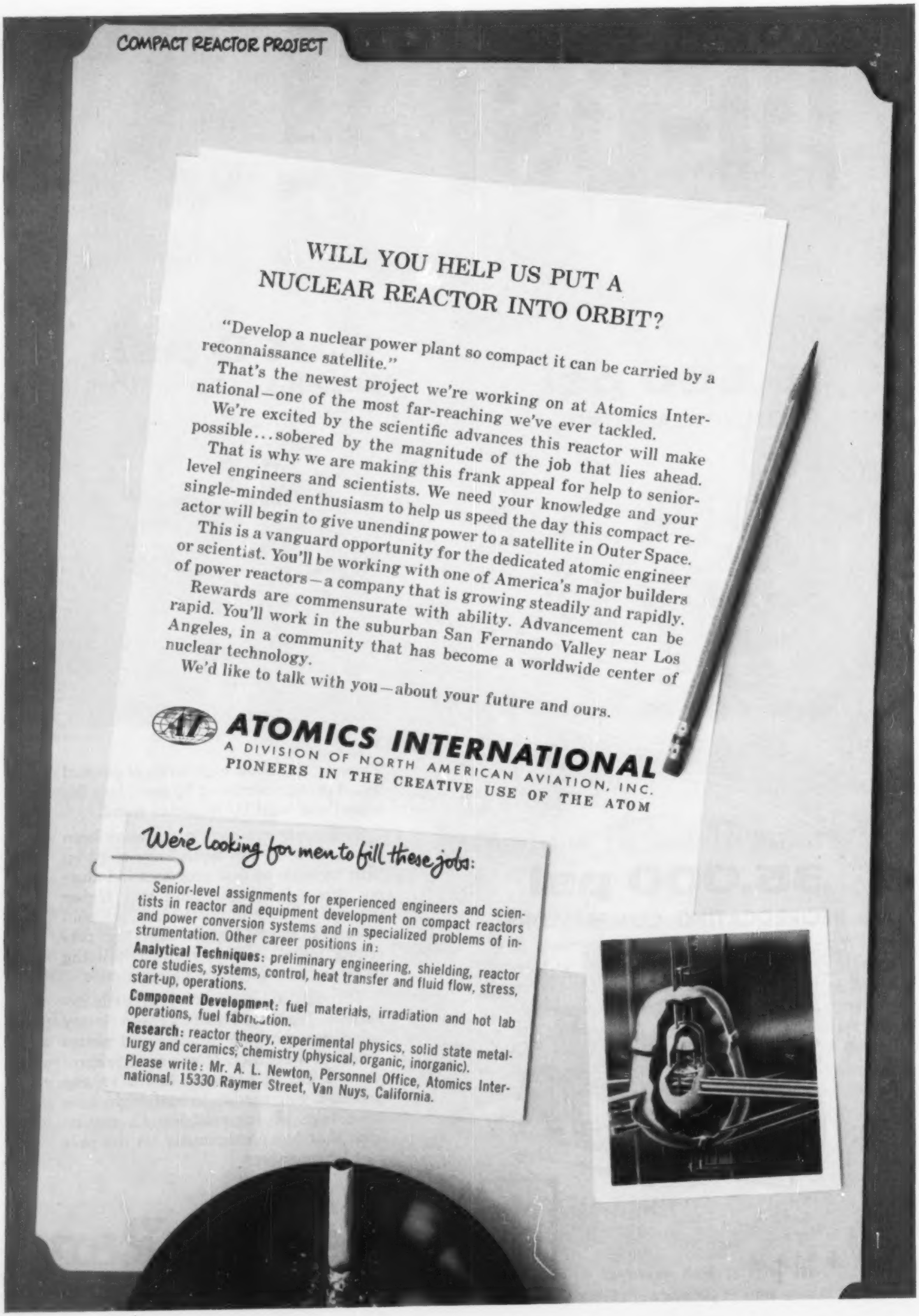
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WILL YOU HELP US PUT A NUCLEAR REACTOR INTO ORBIT?
"Develop a nuclear power plant so compact it can be carried by a reconnaissance satellite."
That's the newest project we're working on at Atomics International—one of the most far-reaching we've ever tackled.
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Please write: Mr. A. L. Newton, Personnel Office, Atomics International, 15330 Raymer Street, Van Nuys, California.

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Members of the ASME are invited to name any number of engineers as candidates for membership. Engineering acquaintances should be qualified by both fundamental training and experience for one of the technical grades. Those who do not have an engineering degree may show the equivalent thereof through actual practice. Executives of attainment in science or industry may associate with the Society as Affiliates.

THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

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The American Society of Mechanical Engineers
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ME-11-58

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Here in the West, where sweeping plains and lofty mesas once challenged the conquistadores of New Spain, Sandia Laboratory now explores new frontiers of science and engineering—seeking the answers to vital questions in many areas of knowledge.

Sandia Corporation was established in 1949 to perform research and development in the ordnance phases of nuclear weapons for the Atomic Energy Commission. This is still our main task, but in doing it we have learned much in the way of theory and advanced technique that has application outside the field of weaponry. For example, Sandia Corporation, working in support of the AEC's nuclear physics laboratories, is currently studying problems concerned with the non-military uses of nuclear energy and with techniques involved in the control of thermonuclear reactions.

Approximately 1,800 engineers and scientists work with the support of 5,700 other employees at our laboratories in Albuquerque, New Mexico, and Livermore, California. These laboratories are modern in design and equipment, with permanent facilities valued at $65,000,000. Equipment available, or in the process of installation, includes an electron and positive ion Van de Graff accelerator, a 5-megawatt tank-type heterogeneous nuclear reactor, a wind tunnel operating in subsonic through hypersonic ranges, digital and analogue computers, and various devices developed for specialized uses. Extensive test facilities are provided for the research and development engineer for proving design theories and concepts.

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Albuquerque is a modern city of about 225,000 people, known for its excellent recreational attractions and its mild, dry, sunny climate. Livermore, located in the San Francisco Bay area, offers suburban advantages close to metropolitan San Francisco. Both are fine places in which to live.

Our illustrated brochure will tell you more about Sandia Corporation and the opportunities it offers to engineers and scientists. Write for your copy to Staff Employment Section 553D.

SANDIA CORPORATION

ALBUQUERQUE, NEW MEXICO

8 REASONS WHY ENGINEERS CHOOSE "BUFFALO" PUMPS

Let's think of pumps in terms of hard service on the job — and the reasons why "Buffalo" Pumps deliver maximum efficiency with minimum maintenance for years and years of such service.
Note these rugged construction features of "Buffalo" Full Ball Bearing Single Suction Pumps:

1. Sturdy cast iron bearing stand and casing mounting ring. These components are interchangeable on all size pumps up to and including No. 3. Engineers like this feature, since they often effect economies by standardizing on one line of pumps with varying capacities.

2. Easily-renewable bronze wearing rings protect casing from wear.

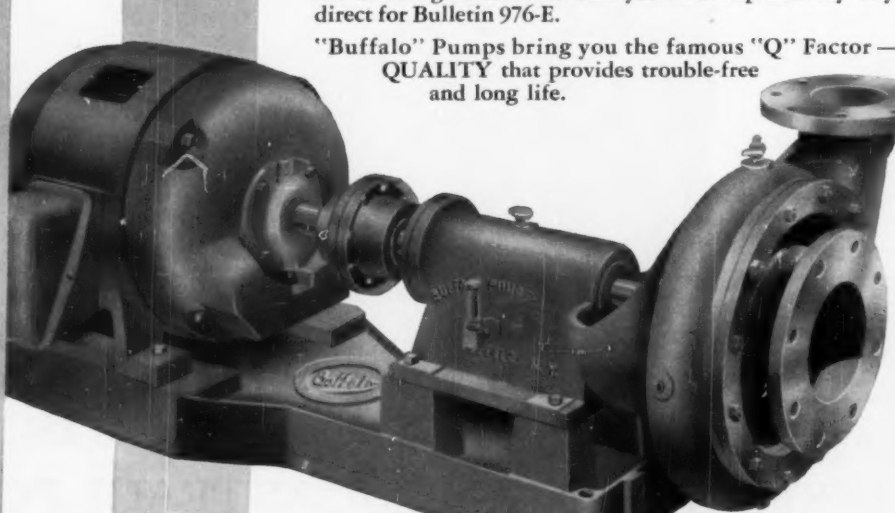
3. High efficiency bronze impeller. Enclosed type has liberal openings to handle abrasive solids. Open type, without wearing rings, is optional.

4. Oversize ball bearings running in oil provide rigid support for shaft and impeller.

Add to these the heavy cast iron frame, oversize shaft, extra-deep stuffing box, long-wearing gland with packing furnished — and you have a total of eight superior engineering features built into every "Buffalo" Single Suction Pump.

These plus many more high quality "Buffalo" components provide the sound reasons why engineers look to "Buffalo" Pumps for a long life of efficient, dependable, economical service. For your next heavy-duty pumping job, contact your nearby "Buffalo" Engineering Representative. He will be glad to work with you and help in every way. Or, write us direct for Bulletin 976-E.

"Buffalo" Pumps bring you the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.



"Buffalo" Single Suction Pump

BUFFALO PUMPS

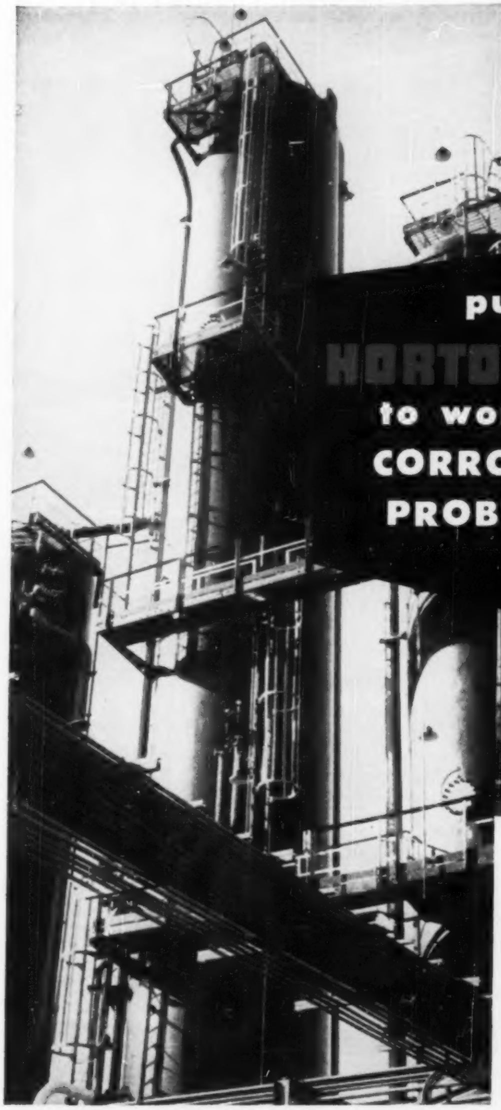
DIVISION OF BUFFALO FORGE CO., BUFFALO, N. Y.

148 Mortimer Street • Buffalo, N. Y.

Canada Pumps, Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

"Buffalo" PUMPS

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



HORTONCLAD makes it practical to fabricate process equipment and structures which provide the same benefits as solid corrosion resistant material at substantially less cost.

Hortonclad is a CB&I-developed corrosion resistant composite metal having an integral and continuous bond of exceptionally high strength. It is produced by a special high-vacuum bonding process and is available only in CB&I-fabricated tanks, pressure vessels and other clad structures.

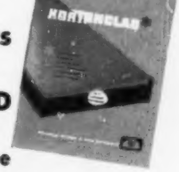
Silver, stainless steels (both chromium and nickel) nickel and alloys such as Monel, Inconel, Hastelloys B and F and a variety of other alloys may be employed in the Hortonclad process. Write our nearest office for a copy of the CB&I bulletin which describes:

(Above)

ABSORBER TOWER at a Louisiana chemical company has stainless steel Hortonclad shell. Thickness of backing and cladding is 1¼ inches.

(Right above)

COKING CHAMBER at a Kansas refinery uses 405 stainless steel Hortonclad backed by A205 Grade A moly steel.



. . . the benefits of HORTONCLAD

1. **Corrosion resistance**
2. **Economy of design**
3. **Uniform thickness of clad and backing plate**
4. **Integral and high strength bond**
5. **Wide selection of cladding materials**
6. **Clean contaminant-free surface**

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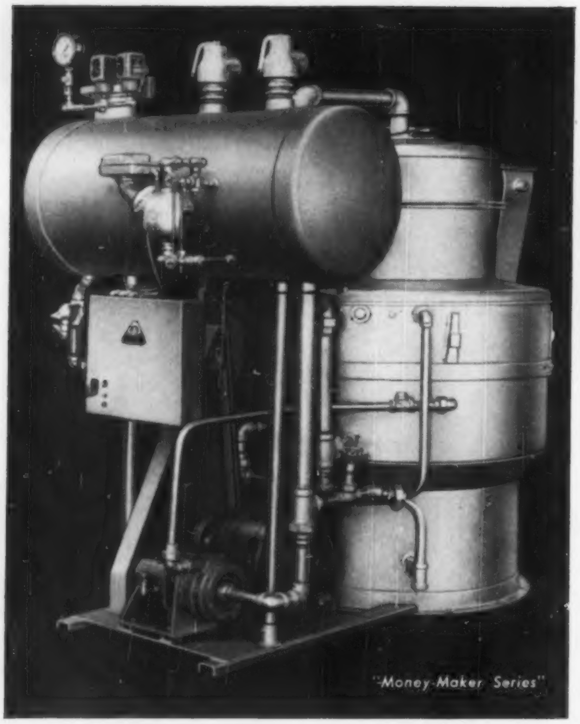

27 MODULĀTIC WATER-TUBE BOILERS

*serve one major food processing company**

SAYS THE CHIEF ENGINEER:*

"After operating one of these units for two years and another for one year, our experience has been excellent and we foresee no future difficulties."

WORLD'S MOST COMPACT WATER-TUBE BOILERS FOR HEATING, POWER, AND PROCESSING

In one-fourth the space of conventional boilers, Vapor Modulātics deliver "push button" steam — automatically, efficiently, quietly.

The Drum Modulātic, shown above, produces 4 BHP per square foot of floor area; features 15-second "cotton soft" starts. Like all Modulātics, it comes completely assembled and wired . . . needs no special foundation or forced-draft chimney . . . installs in just a few hours.

MODULĀTICS NEVER WEAR OUT

Accessible design permits simple replacement of water-tube coils (or other parts) for lifetime peak efficieny. Coils carry a 5-year warranty that includes up to $50 labor allowance. Drum Modulātics deliver 20 to 200 hp; 15 psi steam pressure; 670,000 to 6,690,000 btu/hr . . . instant hot water; full pressure in 5 minutes from cold starts.

THREE WAYS TO BUY

(1) Cash on delivery — 1% discount. (2) 1% 10 days net 30 days to established credit. (3) Extended terms — up to 36 months after down payment. Write today.

FREE LITERATURE! Drum Modulātics Bulletin 475; Modulātics for pressures to 1000 psi, Bulletin 586; Extended Payment Terms, Bulletin 486. Any or all are yours for the asking.
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"MONOBALL"®

Self-Aligning Bearings

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	ANALYSIS	RECOMMENDED USE
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2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Dept. ME-58.

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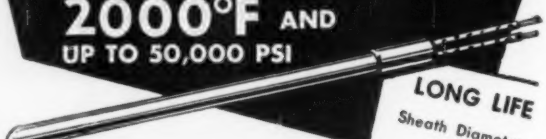
THAT WILL WITHSTAND
2000°F AND
UP TO 50,000 PSI



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Thermocouple Lengths to 50 feet

Complete Thermocouples made to every requirement.

NEW, SIMPLE CONSTRUCTION

A metallic sheath compressed over ceramic insulated wire. Sheath can be bent and weldments can be performed without loss of insulation.

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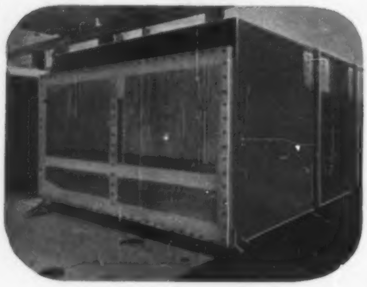
INSTRUMENT COMPANY, INC.
315 NORTH ABERDEEN • CHICAGO 7, ILL.
Sales Representatives throughout the United States and Canada

and auxiliary equipment

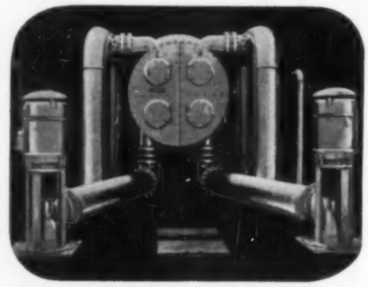
HOW C.H. WHEELER CONDENSER DESIGN

saves space...



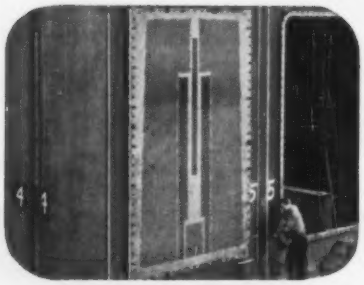
Head Room problems are solved by compact condensers like this one. Turbine floor to basement floor, in this case, is only 20 ft. The Unit has 65,000 square feet of condensing surface.

Rectangular Cross Section makes C.H. Wheeler Condensers adaptable to nearly any space or condenser arrangement because the length, width and height of any Wheeler Unit can be varied almost at will.

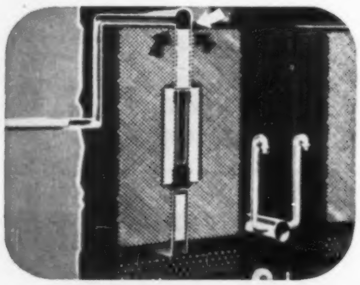


But Wheeler Doesn't limit itself to rectangular design. A round cross section worked out better here, for example, at the first planned gas-steam turbine station ever designed and built in United States.

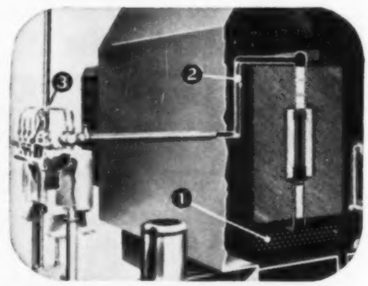
improves power generating efficiencies...



Triple Lane tube layout, another design feature, provides 3 pathways for steam travel, utilizes maximum cooling surface and produces higher condenser vacuums for power generating stations.



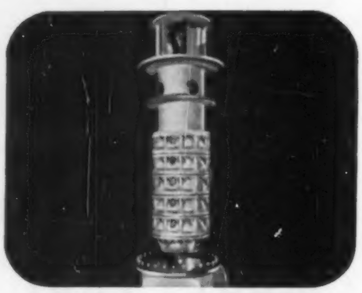
Location of air-vapor takeoff speeds steam travel and allows steam to penetrate to the peripheries of all tubes. It thus improves condenser efficiencies and overall power station operation as well.



Deaeration of condensate not to exceed 0.01 cc. oxygen/liter is available with special Wheeler designs. Note the Deaerating Bars (1), the Air-Vapor Suction Line (2), and Tubejet® Ejectors (3).

and reduces maintenance

Patented Reverse Flow permits flushing tubes and sheets without shutting down Unit, during full load with either or both circulating pumps operating. No additional circulating water inlet or discharge piping necessary with C.H. Wheeler's Reverse Flow.



"Pull-Out" Condensate Pumps simplify maintenance because entire pumping element, including all rotating parts, can be removed without disturbing either the pump barrel or the piping connections.

C. H. Wheeler Circulating Pumps, like Condensate Pumps, are easy to inspect and maintain because of "Pull-Out" design. In addition, shafts are heat treated alloy steel and impellers are statically and dynamically balanced for trouble-free operation.

C. H. Wheeler has been designing and building condensers since 1903; has developed such features as Dual Bank Design and Reverse Flow.

C. H. WHEELER MFG. CO.

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Philadelphia 32, Pennsylvania

Whenever you see the name C. H. Wheeler on a product, you know it's a quality product

Steam Condensers • Steam Jet Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products

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positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.00 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $40.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

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44000KW Steam Generating Plant now under construction, Sea Coast, Southern Peru, the applicant must be capable of taking responsibility for Operation and Maintenance. Should have five to ten or more years' central station experience. For details as to salary, living conditions contact, **Mr. John L. Splane, 410 Arizona Land Title Building, Tucson 1, Arizona.**

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Aggressive Research, Development and Selling have made Edward Valves, Inc., a leader in the steel valve industry. We are expanding our staff and facilities to maintain this position. Have opportunities for—
Engineers (mechanical stress, flow, materials, metallurgical) interested in design and development of valves for high pressure, high temperature service and nuclear power applications.
Sales Engineers—Recent Engineering graduates, preferably M.E. for approximately one year inside sales training prior to assignment to a territory.
Send complete resume in confidence.

EDWARD VALVES, INC.
Subsidiary of Rockwell Manufacturing Co.
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Work includes design, and selection of equipment for: supersonic ramjet engine test stands; environmental test installations; testing of fuel systems; and hydraulic-pneumatic control systems.

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Bachelor's Degree or Better

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A large Mid-west laboratory offers an excellent opportunity for engineers to enter the fast growing field of new cryogenic products. Work consists of new product exploration, development and engineering for aircraft, missile and commercial applications. Applicants with training and direct experience in cryogenic work as well as recent graduates are desired. Versatility, creativity and high technical capability required.

Send details of experience, education and salary requirements. Replies will be given prompt consideration and will be held in complete confidence. **Address CA-6568, care of "Mechanical Engineering."**

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Mid-West mfg. firm seeks man to analyze, design and develop electro-hydraulic servo valves. M.E. degree, advanced math. study using LaPlace's transformations. Experience servo valve design helpful. Salary to $13,000. Send resume.

Address CA-6571, care of "Mechanical Engineering."

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A leading engineering organization with world-wide operations has established and is expanding a long range program of research and development in physical science and applied mechanics to supplement its existing programs in the design and construction of petroleum, chemical and metallurgical plants.

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High intensity combustion chambers, process burners, surface combustion, burning in jets, explosions and detonations.

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FLUID DYNAMICS
2-phase flow, flow with reaction, transient phenomena, fluidized solids behavior, shock waves, votex flow and magneto-hydrodynamics.

Please write full details in confidence to R.L. Stacom

The M. W. KELLOGG Co.
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Los Alamos, New Mexico

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The Engineering Mechanics Department of Southwest Research Institute has a limited number of attractive positions for well qualified personnel. These positions offer an outstanding opportunity for challenging work in structural mechanics, theoretical and applied mechanics, and experimental stress analysis. A wide range of assignments on programs related to missiles, ships, submarines, space vehicles, nuclear power, pressure vessels, off-shore drilling systems, and weapons effects, accelerate the rate of professional progress.

Candidates should have an M.S. or Ph.D. degree with research experience being desirable. Please send resume and salary requirements to:

Mr. R. C. Mays, Personnel Director
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SALES ENGINEERS WANTED

for St. Louis and New York. Prefer graduate Chemical or Mechanical Engineers with two or three years' experience after finishing college, preferably in the process industries. Mail reply to

H. E. Beane, Vice President,
The Bristol Company,
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Mechanical Engineers experienced in mechanical design for packaging electronic equipment to meet environmental conditions.

FLUID MECHANICS ENGINEERS

Engineers of advanced standing for work in basic and applied research in field of underwater propulsion and related subjects, including cavitation, hydroelasticity, and hydrodynamic control of submerged bodies.

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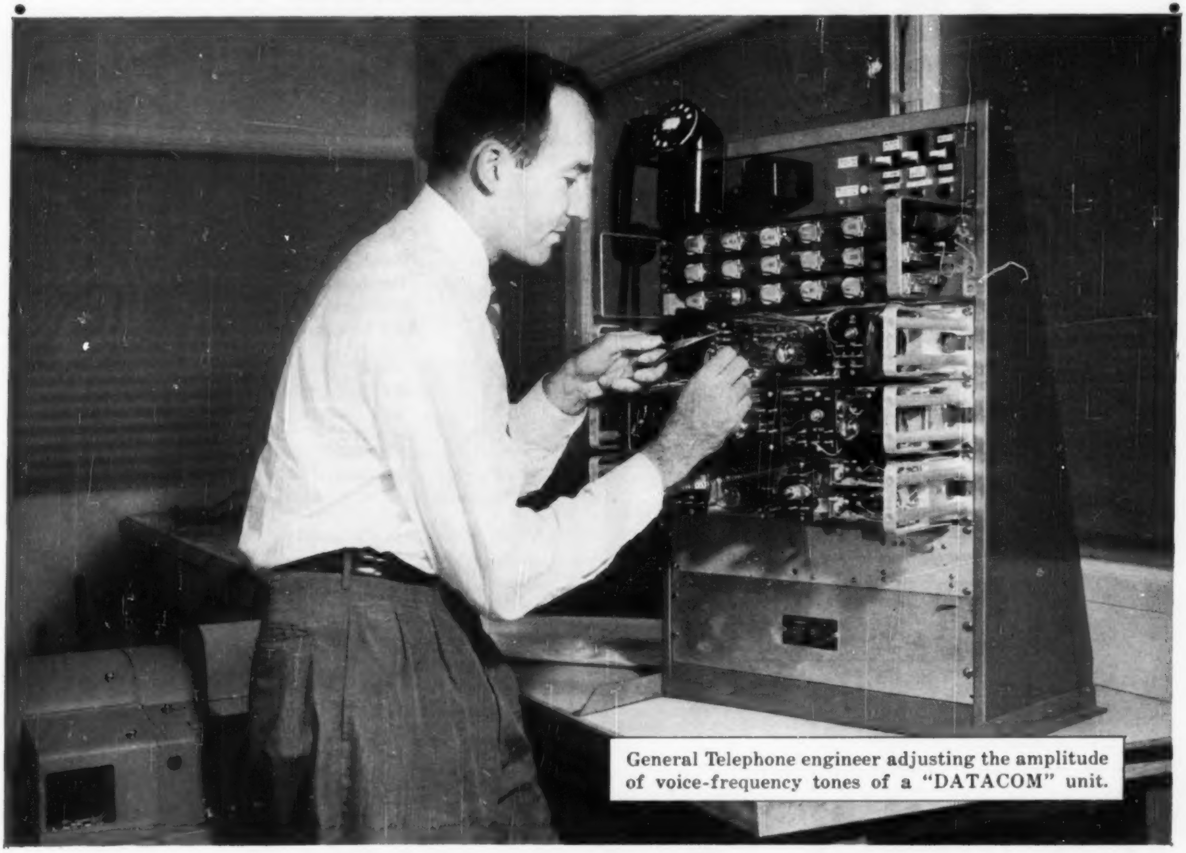

General Telephone engineer adjusting the amplitude of voice-frequency tones of a "DATACOM" unit.

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Excellent opportunity for thermodynamics engineer with extensive experience in aircraft installation and cooling work. Should have good background in heat transfer, packaging and aircraft structures.

Qualifications

Engineering degree and 3 to 5 years' experience.

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A recognized leader in the electronic computer field; stable balance of military and commercial work; advancement on merit; company-paid relocation expenses; liberal company benefits; salary commensurate with ability and experience.

Immediate openings at Owego, N. Y.

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Outstanding opportunities exist in the Structures Section for young creative and imaginative engineers. These positions offer an opportunity to work in small project groups in an intimate environment with some of the leading engineers in this field. We need men who are interested or have experience on research problems in:

Structural Dynamics
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These positions are non-routine and require men with initiative and resourcefulness. Degree in Mechanical Engineering, Civil Engineering or Mechanics required.

Excellent employee benefits including tuition free graduate study and a liberal vacation policy.

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ARMOUR RESEARCH FOUNDATION
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Illinois Institute of Technology
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ELECTRICAL OR MECHANICAL ENGINEERS
for Naval Nuclear Power Plant Development

The Central Technical Department of Bethlehem's Shipbuilding Division, an experienced organization recognized for its technical achievements, offers unusual opportunities for engineers qualified to participate in our nuclear power program.

Control Engineers: Development of control, instrumentation, and monitoring systems, and functional arrangement of control and operating stations.

Electrical Engineers: Overall design of electric power system, systems analyses, and development of installation details for special applications.

Minimum qualifications for these positions are:

1. **B. S. in electrical or mechanical engineering**
2. **Advanced study at a graduate level—preferably in electronics, servo-mechanisms or nuclear engineering**
3. **Four years' experience in marine or closely allied industry**
4. **U. S. citizenship**

If you would make full use of your professional training in creative engineering, enjoy easy commuting and have convenient access to New England's educational and recreational facilities, you are invited to write to us. Your inquiry will be considered confidential and acknowledged promptly.

Please address your resumé to:

BETHLEHEM STEEL COMPANY
Shipbuilding Division

CENTRAL TECHNICAL DEPARTMENT
Quincy 69, Massachusetts
Attention C. H. Goldthwaithe, Assistant Manager

POSITIONS OPEN

University graduate Engineer with at least five years' experience operation steam electric generating station for responsible position in Maracaibo, Venezuela. Preference will be given Spanish speaking applicant. Salary dependent on qualifications. Address CA-6506, Care of "Mechanical Engineering."

AVAILABLE FOR FEBRUARY 1959, positions with rank of Assistant Professors, Instructors, and part-time Graduate Assistants in Engineering Mechanics for both teaching and research. Excellent opportunities for graduate study. Address CA-6562, care of "Mechanical Engineering."

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MECHANICAL ENGINEER with up to five years' actual design experience. Duties include design work in chemical process plant facilities such as acid piping, conveying equipment, dryers, filters and gas handling equipment. Board work required. Send resume outlining education, experience, and salary desired to P.O. Box 3269, Tampa, Florida.

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MECHANICAL ENGINEERS, THERMODYNAMICISTS, CHEMICAL ENGINEERS AND PHYSICISTS, with fluid dynamics background

THE AIRCRAFT REACTOR IS CREATING A NEW REGIME IN HEAT TRANSFER AND HOT MACHINERY DESIGN

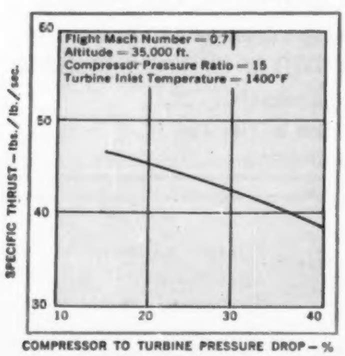
PAUL E. LOWE, *Manager, Thermodynamics and Mechanical Development for General Electric's Aircraft Nuclear Propulsion Dept. explains some of the new design parameters encountered on this pioneering program to an engineer with a background in conventional propulsion systems.*

Q. ***Mr. Lowe, what are the new parameters affecting heat transfer design for the aircraft nuclear power system?***

A. I can give you an indication, Mr. Albans, though specific data in this area is classified.

We are working here with a non-homogeneous reactor of new design. The big overall problem is to get all parts of the heat generating core working as near maximum as possible. The heat difference in the reactor between the hottest spots and the bulk fluid temperature must be reduced in order to deliver power, at a pre-determined temperature, to the turbine inlet that will utilize the full capabilities of the entire propulsion system.

Mechanical components must be developed with maximum strength to weight ratios. As you can see, these are real challenges to the engineer.



Small pressure drop between compressor discharge and turbine inlet means high specific thrust. Typical curve for a hypothetical direct-cycle turbojet aircraft propulsion system shows lowering of specific thrust with increasing pressure drop through reactor and shield ducting system. High turbine-inlet temperature also contributes to high specific thrust.

Q. ***What about thermal stress?***

A. Here again, I can't give you figures. However, a reactor of the small size and high power density which the weight limitations of an aircraft application make obligatory, develops temperature gradients that are more severe than those engineers, in other reactor systems, have encountered. This gives the nuclear designer new thermal stress parameters to work with.

Also new reactor materials have had to be developed at ANP to withstand the high temperatures and radiation conditions encountered.

Q. ***Then additional new parameters result from the use of new alloys, cermets and coatings?***

A. That is so, Mr. Albans. An ANP design engineer is working in a field that is still embryonic in learning how to fully exploit high strength, and therefore brittle, materials in structural shapes, and mechanical devices. We must become sophisticated in such designs.

Considerable advances have been made here, however, in the design of really high temperature mechanical components and structures. This requires ingenuity and competent analysis to achieve technical understanding and permit operation at very low stress levels.

Q. ***Mr. Lowe, can an engineer work effectively on mechanical design and thermodynamic problems at ANP without previous training in nucleonics?***

A. Certainly. The engineer we want to join our staff is one who has high intelligence, plus the capability to apply what knowledge he already has. We want top performers in native mental abilities with sound basic technical background.

Openings for MECHANICAL ENGINEERS, THERMODYNAMICISTS, CHEMICAL ENGINEERS *and* PHYSICISTS (with fluid dynamics background). Nuclear experience is not required. Necessary training and information in nucleonics will be provided through in-plant seminars, contact with associates and graduate courses at the University of Cincinnati on General Electric's 100% Tuition Refund Plan. Write in confidence including salary requirements, to: Mr. P. W. Christos, Division 40MW, Professional & Technical Personnel.

AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

GENERAL ELECTRIC

P.O. Box 132 · Cincinnati 15, Ohio

A few openings in other areas of the program for: Nuclear Engineers • Metallurgists • Physical Chemists • Solid State Physicists • Ceramists

POSITIONS WANTED

MECHANICAL ENGINEER, 27, single, 2 years' designing experience in high-pressure-heat-exchanging and the construction of apparatus and pipe-lines for power plants, knowledge of German and English, seeks employment. Address CA-6561, care of "Mechanical Engineering."

MECHANICAL ENGINEER, 5 years' diverse experience in process control, dynamics and stress analysis; research, design and development of automobile-motors; shock and vibration equipments. Desires similar position; will relocate. Address CA-6565, care of "Mechanical Engineering."

MECHANICAL ENGINEER—39, B.S., Registered. 15 years' experience developing instruments, valves and controls (electromechanical, hydraulic, pneumatic). Now supervising development, manufacture and sales of automatic controls for oil field use. Address CA-6573, care of "Mechanical Engineering."

MANAGEMENT ENGINEER: Have worked in various phases of industrial engineering field-standards, methods and design plus planning, production follow-up and coordinating procedures. Seeking brighter future. Address CA-6574, care of "Mechanical Engineering."

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Large U. S. manufacturing company wants mechanical or electro-mechanical products of small to medium size for manufacture in England and world-wide distribution outside North America.

Address CA-6560, % "Mechanical Engineering."

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SALARIED POSITIONS—$6,000 to $35,000. We offer the original personal employment service (established 47 years). Procedure of high standards individualized to your personal requirements. Identity covered. Particulars—R. W. Bixby, Inc., 562 Brisbane Bldg., Buffalo 3, N. Y.

SALARIED PERSONNEL $5,000 to $30,000. This nation-wide service successful since 1927 finds openings in your field. Sells your abilities; arranges contacts. Present position protected. Write for details—Jira Thayer Jennings, P. O. Box 674, Manchester, Vermont.

REPRESENTATION WANTED

MANUFACTURER of Heat Exchangers and Pressure Vessels, located in New Jersey, wants sales representatives in various parts of country. Representative should have contacts in oil refineries, power plants, chemical plants or marine. Address CA-6550, care of "Mechanical Engineering."

MECHANICAL ENGINEERING

October, 1958 — CARD INDEX — Vol. 80, No. 10

For Reference

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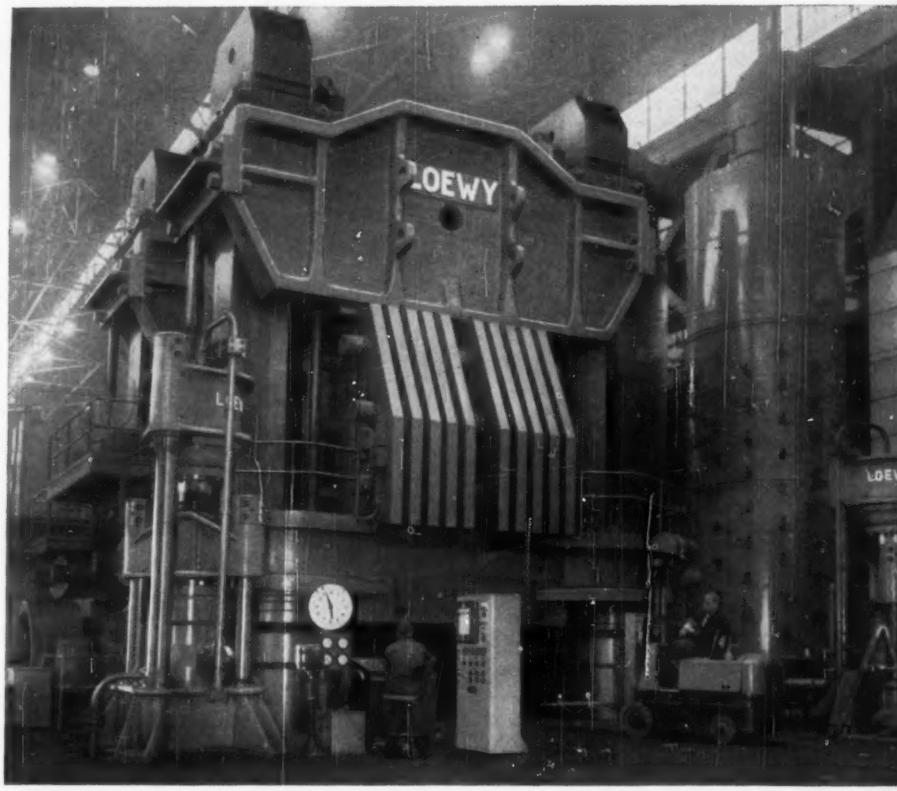

One of the largest presses in existence, this closed die forging press designed and built by Loewy, and in operation at the Wyman Gordon plant, North Grafton, Mass., features automatic program speed control.

Structural and machine parts in aircraft, missiles and nuclear apparatus today demand greater strength and resistance to high temperatures, and many have extremely thin areas. Machining and other metal removing processes are not economical, due to the high cost of labor, waste of expensive alloy material, and loss of structural strength from cutting across the flow lines of metal. New metals, new methods and new equipment are needed for the economical production of parts that will consistently meet the severest requirements.

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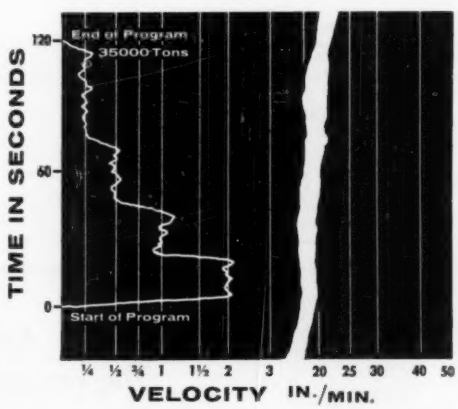

Graph shows a typical automatic control cycle consisting of four preselected speeds at preselected stroke positions up to 2 in./min. The workpiece is a 36-in. diameter steel billet. Pressure ranges from 6000 to 35,000 tons. Speeds range from ¼ in./min. to 2 in./min. and total pressing time is 2 minutes.

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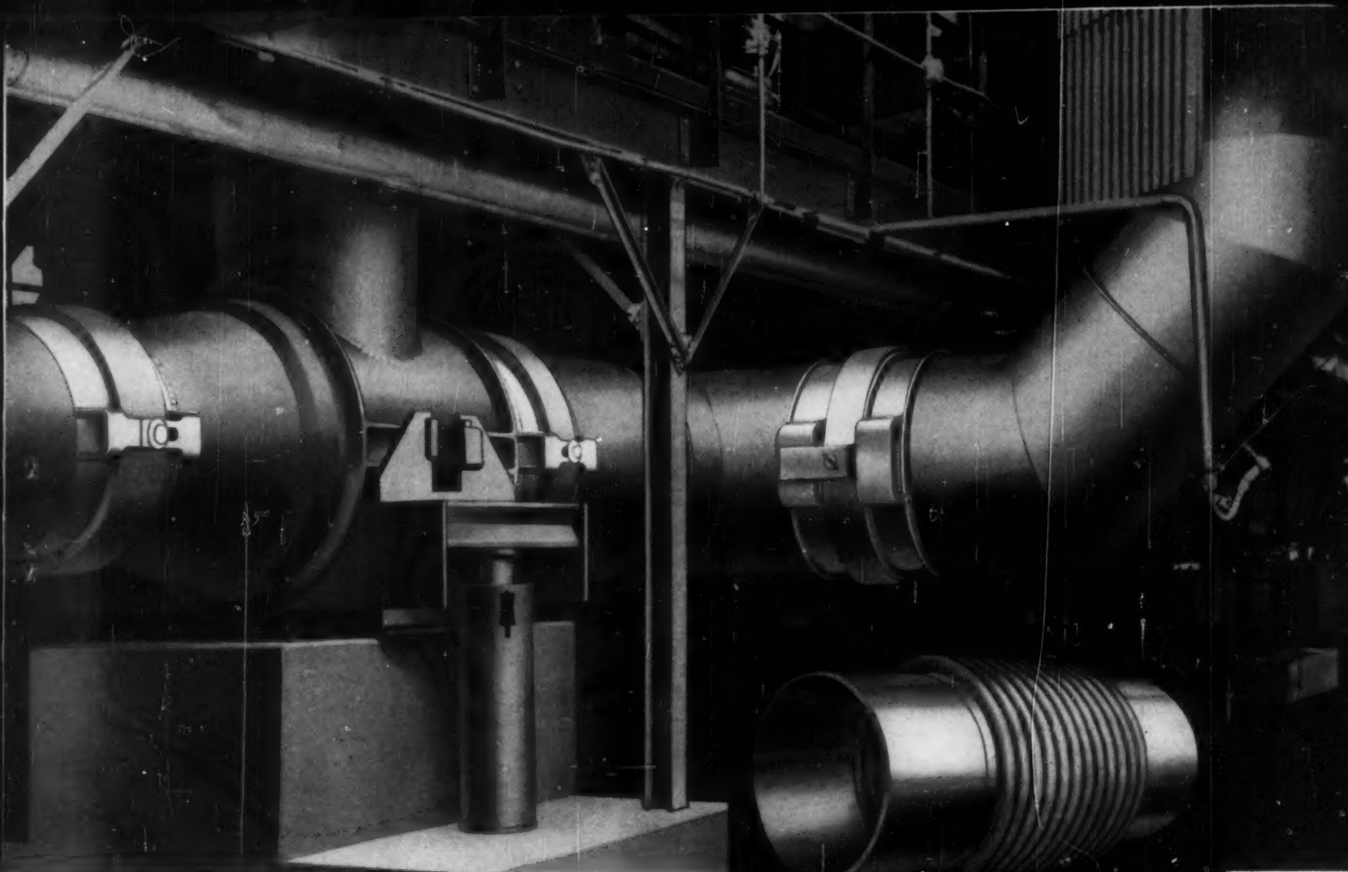

View of hydrocarbon outlet line just below reactors shows three of a total of 67 Badger S-R Expansion Joints at Firestone's new Butadiene Plant at Orange, Texas. Joints shown are equipped with guide bars and external covers.

Series 50W S-R Expansion Joint
Shown with cover removed

Badger S-R Expansion Joints handle rugged 1100° service at Firestone's new plant

The Houdry process used at Firestone Tire and Rubber Company's new Butadiene Plant calls for temperatures up to 1100°. Add critical forces on anchors and connected equipment, wind loading, and complex piping arrangements and you have real problems in piping and expansion joint design.

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New corrugation and ring designs produce better equalization, "all-curve" flexing

Curvilinear Corrugations used in S-R Expansion Joints were developed by the Badger Research Department. Under operating pressures (white line) the new design produces more uniform movement per corrugation and natural "all-curve" flexing. Stress is reduced . . . life increased.

Series 50 corrugation cross-section

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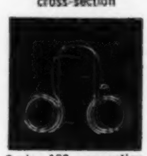

Series 150 corrugation and ring cross-section

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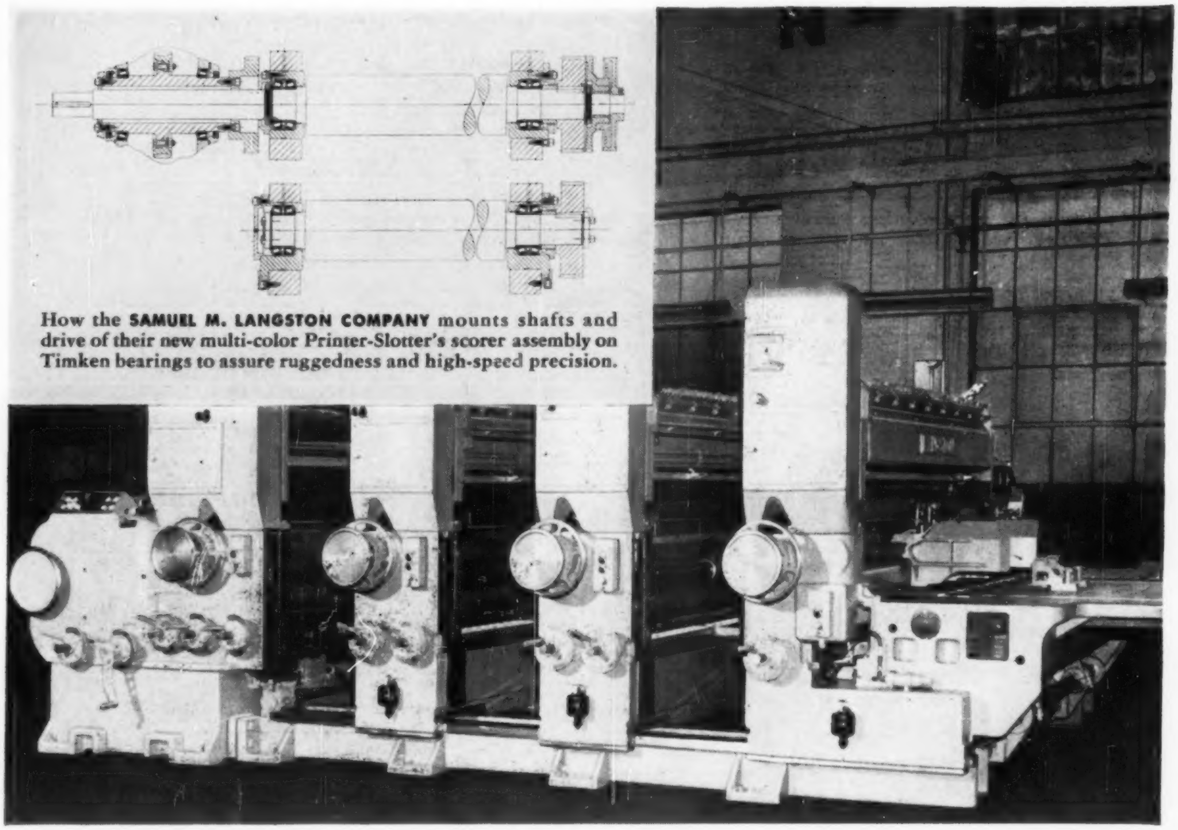

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